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ABSTRACT

Text, illustrations, and exercises are utilized in a set of six learning modules designed to instruct allied health services students and practitioners in necessary vocabulary skills and in selected job-related competencies. The first module, "Step into Medical Terminology" by Faye Ivor, teaches students to recognize the meaning of selected word roots, prefixes, and suffixes in medical terminology. The second module, by Barry Braverman, explains how to invent and use memory keys in the form of visual images that can help the student remember the meaning of common word roots in the medical vocabulary. The third module, by Charles Afflerbach, describes how to read and interpret grided scientific scales, such as thermometers, in the decimal system. The fourth module, by John Ferrara, examines the parts and use of the compound light microscope. The fifth module, by William J. Boykin, describes the parts of the stethoscope and details techniques and procedures for its use in auscultating the chest. The sixth module, by Bette Stanley, discusses the basic principles of the nature of light and examines the applications of those principles in photometry. Each of the illustrated modules outlines specific behavioral objectives, describes and illustrates procedures, provides sequential reinforcement exercises with immediate feedback, and concludes with a post-test and an accompanying answer key. The amount of time required to complete the modules varies from 20 to 30 minutes. (JP)

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HEALTH INSTRUCTION PACKAGES:

Basic Skills and Competencies

Modules prepared by:

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JC 810 323

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STEP INTO MEDICAL TERMINOLOGY

by

Faye Ivor

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Title:	Step into Medical Terminology
Author:	Faye Ivor
Institution:	St. Joseph's Hospital and Medical Center Phoenix, Arizona
Intended Students:	Allied health personnel and paramedics; interested patients
Estimated Working Time:	30 minutes
Materials Needed:	None
Revised:	June 15, 1977

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INTRODUCTION

This self-instructional packet is an introductory unit to medical terminology. This is a different language used in the health services and is derived from Latin and Greek primarily, and some German and French. But don't let this frighten you off! You do not need a foreign language background to translate medical terms into English.

If you follow this self-instruction packet through the next several pages, you'll have a start for daily usage and to build on.

We hope your interest will be stimulated and that you will look for resources to increase your knowledge "bump".

In the meantime, have fun looking into this packet of "strange language".

OBJECTIVES OF UNIT

Overall Objective

The student will be able to translate selected medical terminology into English, and identify the word elements.

Sub-Objectives

1. You will be able to label the root position of the term and translate it to English.
2. You will be able to label the prefix portion of the term and translate it to English.
3. You will be able to label the suffix portion of the word and translate it.
4. You will willingly request more resources for further study of medical terminology.

PRACTICE EXERCISE #1

The root portion of the word is the body or main part of the word and usually describes the organ involved.

Examples: dyspnea - pnea is root, refers to breathing.

hypoglycemia - glyco is root, refers to sugar.

appendicitis - append is root, refers to appendix.

cholecystectomy - chole is bile, cyst is bladder, both are roots. (The gall bladder stores bile.)

bronchoscopy - broncho is root, refers to bronchus, a main branch of the windpipe.

colostomy - colo is root, refers to the large intestine, colon.

thorocotomy - thoro is root, refers to thorax, the chest.

Practice Question #1

Underline the root portion of these words and translate the root only.

1) colitis -

2) bronchogenic -

3) cholecystostomy -

4) appendectomy -

5) apnea -

6) glycosuria -

Feedback

1) col - colon

2) broncho - bronchus

3) cholecyst - gall bladder

4) append - appendix

5) pnea - breathing

6) glyco - sugar

PRACTICE EXERCISE #2

A prefix is a word element added at the beginning of a word which changes or modifies the meaning.

Examples:

Prefixes	In Usage
a, an - without, absence of	aseptic - absence of infection
anti - against	antitoxin - against poison
dys - difficult, bad	dyspnea - difficult breathing
hyper - greater than normal, excessive	hyperglycemia - abnormally high blood sugar
hypo - lower than normal	hypoglycemia - abnormally low blood sugar

Practice Question #2

Underline the prefix portion of these words and translate the prefix:

1) hypothyroidism -

2) dystrophy -

3) anuria -

4) antiseptic -

5) hyperacidity -

FEEDBACK

1) hypo - lower than normal

2) dys - difficult

3) an - absence of; without

4) anti - against

5) hyper - greater than normal; excessive

PRACTICE EXERCISE #3

The suffix is a word element added at the end of a word which changes or modifies the meaning.

Examples:

Suffixes	In Usage
ectomy - surgical removal of	cholecystectomy - surgical removal of the gall bladder
scopy - examination with an endoscope (instrument like a periscope)	bronchoscopy - examination of the bronchus
stomy - a surgical creation of an opening	colostomy - a surgical opening into the colon (large intestine)
centesis - a puncture into, usually to withdraw fluid	thoracentesis - a puncture into the thorax (chest)
itis - inflammation of	appendicitis - inflammation of the appendix
emia - blood	hypoglycemia - low blood sugar
osis - condition of	dermatosis - condition of the skin
tomy - an incision into	tracheotomy - an incision of the trachea

Practice Question #3

Underline the suffix portion of these words and translate the suffix:

1) gastrectomy

2) enterostomy

3) abdominocentesis

4) gastroscopy

5) hepatitis

6) septicemia

Feedback

1) ectomy - surgical removal of

2) stomy - a surgical opening into

3) centesis - a puncture into

4) scopy - examination with an endoscope

5) itis - inflammation of

6) emia - blood

PRACTICE EXERCISE FOR OVERALL OBJECTIVE

1) nephrolithiasis - nephro - kidney (root)
lith - stone (root)
iasis - presence of; condition of (suffix)

Translation: presence of kidney stones

2) erythrocyte - erythro - red (prefix)
cyte - cell (root)

Translation: red (blood) cell

3) pyelonephritis - pyelo - pelvis of (root)
nephro - kidney (root)
itis - inflammation of (suffix)

Translation: inflammation of pelvis of the kidney

Practice Question

Translate and identify root, prefix, and suffix in words below:

1) nephrectomy -

2) cholelithectomy -

3) pyelonephrosis -

PRACTICE EXERCISE FOR OVERALL OBJECTIVE (cont.)

1) surgical removal of kidney - nephro (root), ectomy (suffix)

2) incision into gall bladder for removal of stones - chole (root), lith (root), otomy (suffix)

3) Condition of the pelvis of the kidney - pyelo (root), nephro (root), osis (suffix)

There is further information on medical terminology available in: Learning Medical Terminology Step by Step, Young and Barger, 3rd edition, and in Understanding Medical Terminology, Frenay, Sr. Agnes Clare.

POST-TEST

Answer True or False:

___ 1. The root portion of the word describes the organ involved in the disease process.

___ 2. The suffix portion of the term is added at the beginning of a word.

___ 3. The root portion of the word is the body or main portion of the word.

___ 4. The prefix is a word element added at the end of a word.

___ 5. Prefixes and suffixes change or modify the meaning of the word.

From the list below, identify (label) the prefixes and suffixes and translate the word element:

6. a, an -

7. centesis -

8. emia -

9. hyper -

10. scopy -

11. dys -

12. hypo -

13. ectomy -

14. anti -

15. stomy -

16. itis -

POST-TEST (cont.)

Please match column B with column A and underline the root portion of each term in column A:

Column A	Column B
___ 17. hyperglycemia	a. examination of the bronchi with an endoscope
___ 18. appendicitis	b. a protein that defends the body against a toxin (poison)
___ 19. thoracentesis	c. low blood sugar
___ 20. cholecystectomy	d. difficult breathing
___ 21. bronchoscopy	e. inflammation of the appendix
___ 22. colostomy	f. abnormally high blood sugar
___ 23. asepsis	g. removal of the gall bladder
___ 24. antitoxin	h. puncture and aspiration of the pleural cavity
___ 25. dyspnea	i. without infection
___ 26. hypoglycemia	j. creation of an opening into the colon through the abdominal wall

POST-TEST ANSWER KEY

True or False Questions:

1. True
2. False
3. True
4. False
5. True

---

6. Prefix - without, absence of
7. Suffix - a puncture into, usually to remove fluid
8. Suffix - blood
9. Prefix - greater than normal, excessive
10. Suffix - examination with an endoscope
11. Prefix - difficult, bad
12. Prefix - lower than normal
13. Suffix - surgical removal of
14. Prefix - against
15. Suffix - a surgical opening into
16. Suffix - inflammation of

	Root portion of the word underscored:
17. f	17. glyc
18. e	18. append
19. h	19. thora
20. g	20. cholecyst
21. a	21. broncho
22. j	22. colo
23. i	23. sepsis
24. b	24. toxin
25. d	25. pnea
26. c	26. glyc

ANONYMOUS ATTITUDINAL EVALUATION

1. On a scale of 1 to 5, rate this self-instruction package by circling the appropriate number in each category below.

Clear	1	2	3	4	5	Confusing
Useful	1	2	3	4	5	Useless
Stimulating	1	2	3	4	5	Boring
Important	1	2	3	4	5	Unimportant

2. This package could be improved by _____

_____

_____

3. I would like the teacher to include _____

_____

_____

4. I would like more self-instruction packets like this:

yes ___ no ___

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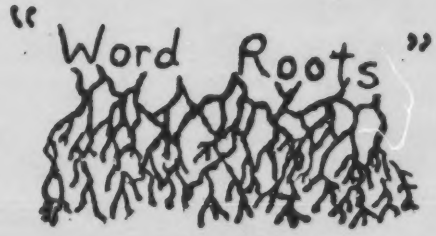
USING IMAGERY FOR MEMORY KEYS TO LEARN HEALTH RELATED TERMS

by

BARRY BRAVERMAN



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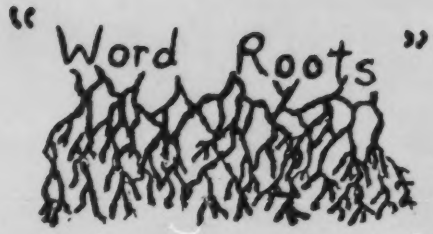

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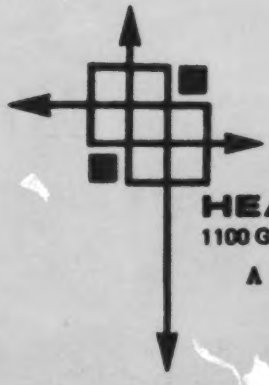
TITLE OF PACKAGE:	Using Imagery for Memory Keys to Learn Health-Related Terms
AUTHOR:	Barry Braverman
INSTITUTION:	Health Instruction Exchange, Los Angeles, Calif.
INTENDED STUDENTS:	Community college health-science students
ESTIMATED WORKING TIME:	35 minutes
MATERIALS NEEDED:	None
REVISED:	July 1, 1977



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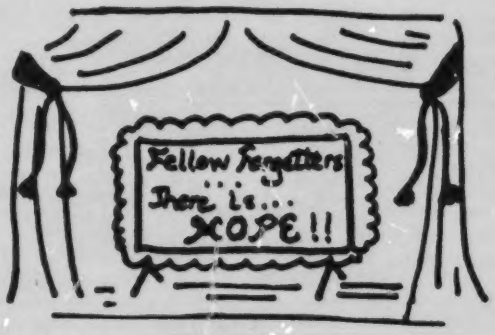
Have you ever known anyone with a photographic memory? There are people who can look at a page of material for a few seconds and remember every detail hours or even days later. Unfortunately, most of us lack this talent, and are forced to struggle along with our own imperfect powers of recall.

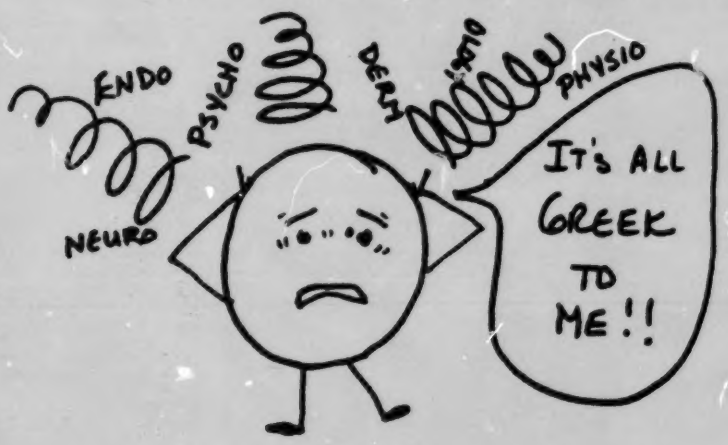


You can improve your ability to memorize by learning some very simple tricks. This package will teach you one of these tricks, which we'll call the "MEMORY KEY" technique.

As a student in the Health Sciences, you are frequently asked to commit material to memory. Memory keys can help you do this faster and more effectively, not only in medical terminology but for anything you'd like to remember. Memory keys are simply visual images which you invent to help you remember something.

In this package, you'll be memorizing health-related terms and their meanings. The terms you'll encounter in this package will be referred to as WORD ROOTS. These word roots are words or parts of words that have come down to us from Greek and

Latin. An example of a word root is "hemo" which means "blood". Learning the meaning of a word root has a great deal of power because it enables you to figure out the meaning of other words that contain the same root. For example, "hemophilia" refers to a condition in which the blood does not coagulate. Scientific and medical terminologies are loaded with Greek and Latin word roots. Every root that you learn can help you unlock many more words. Whoever said, "a picture is worth a thousand words" must have known about Memory Keys. This method of memorizing is based on the assumption that it is easier to recall a picture than a word. You'll see more clearly what I mean as you get farther into the package. For now, simply remember that Memory Keys are visual images that contain the information you want to memorize. (If you can't remember that, you really need this package).



Here are the objectives of this unit:

Overall Objective

When you complete this package, you'll be able to memorize the definitions of 5 health-related word roots with 5 minutes of study.

Sub-Objectives

You'll be able to determine whether 2 sample Memory Keys meet the 3 criteria presented in this package.

Given 3 health-related word roots and their definitions, you'll be able to draw a Memory Key for each root which meets the criteria presented in this package.

Given the same 3 roots in Sub-Objective 2, you'll be able to remember and write the meaning of each root.

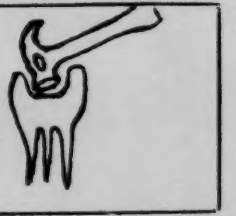
Given 5 minutes to study 5 health-related word roots and their definitions, you'll be able to memorize at least 3 out of the 5.

PRACTICE CYCLE 1

You are now ready to begin exercising your memory. You know from the introduction that a Memory Key is a visual image that you invent. There are 3 criteria that this image or mental picture must meet if it is to be an effective Memory Key.

1. It must be visual.
2. It must be unusual.
3. It must include all the information you want to memorize.

A look at Sample A should clarify these criteria:

Sample A	Information to be memorized	Memory Key
	"dent" means "tooth"	

The Memory Key in Sample A is my way of remembering that "dent" means "tooth". The picture of a hammer putting a dent in a tooth contains all the information I need. If I can remember this mental picture, I can remember the definition of the word root, "dent".

Let's see whether the Memory Key in Sample A meets the 3 criteria above:

1. Is it visual? _____
2. Is it unusual? _____
3. Does it include all the information I want to memorize? _____

I hope you answered "yes" to all 3 questions. If you didn't think my Memory Key was unusual, that's OK too. The important thing is that the person who invents the key thinks it's unusual. After all, he's the one who wants to remember it!

Now, let's see if you can evaluate some Memory Keys according to the 3 criteria.

Sample B	Information to be Memorized	Memory Key
	"glosso" means "tongue"	

Evaluation of Sample B

1. Is it visual? _____
2. Is it unusual? _____
3. Does it include all the information I want to memorize?____

You should have answered, Yes, Yes, NO. The problem with Sample B is that there is no clue for "glosso" in the Memory Key, so that even if you can recall the picture, all you can get from it is "tongue".

Now, try the same type of evaluation with Sample C:

Sample C	Information to be Memorized	Memory Key
	"derm" means "skin"	"Derm" sounds like "worm" and a worm has skin.

Evaluation of Sample C

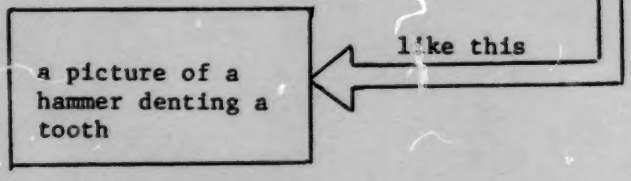
1. Is it visual? _____
2. Is it unusual? _____
3. Does it include all the information I want to memorize? ____

Your answers should be NO, NO, and YES. (If you're unclear about these answers, please reread this section of the package).

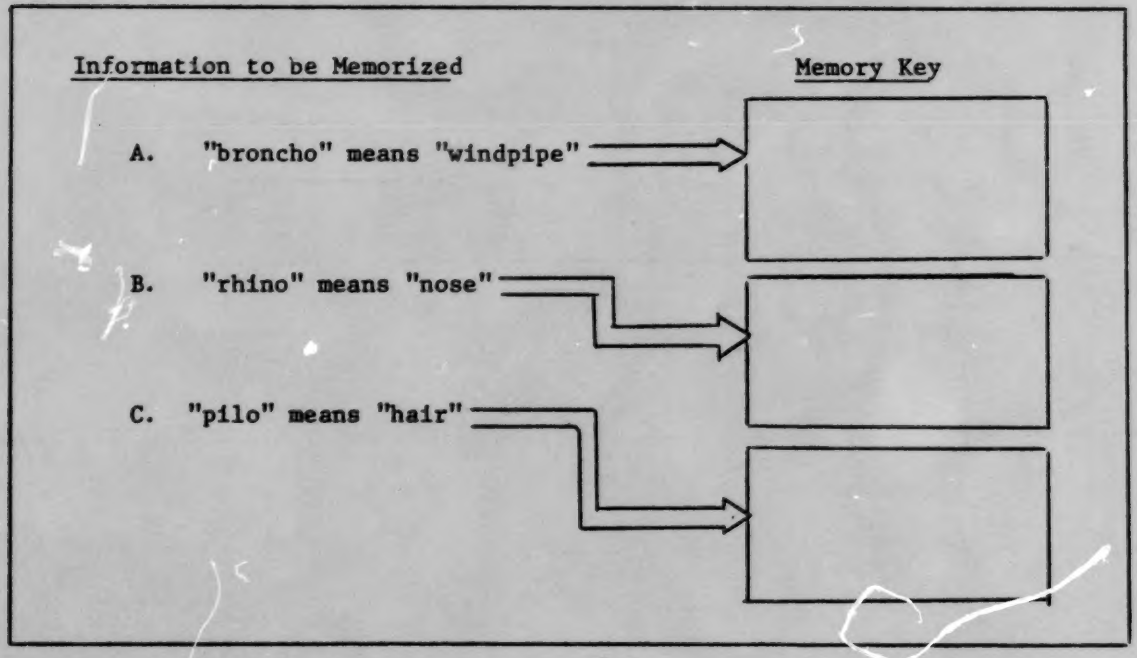
PRACTICE CYCLE 2

At this point, you should be ready to start making up your own Memory Keys, so let's get on with it!. Keep in mind that the Keys you make up are your Keys. No one can tell you whether they're right or wrong. The only valid question to ask is: DO THEY WORK? (You'll have an opportunity to find out in Practice Cycle 3).

One word of caution before you begin. You are asked to draw your Memory Keys because they are visual devices. Chances are you're not an artist. Don't worry about the drawing; just try to convey the idea. If you simply can't come up with a drawing, use words instead

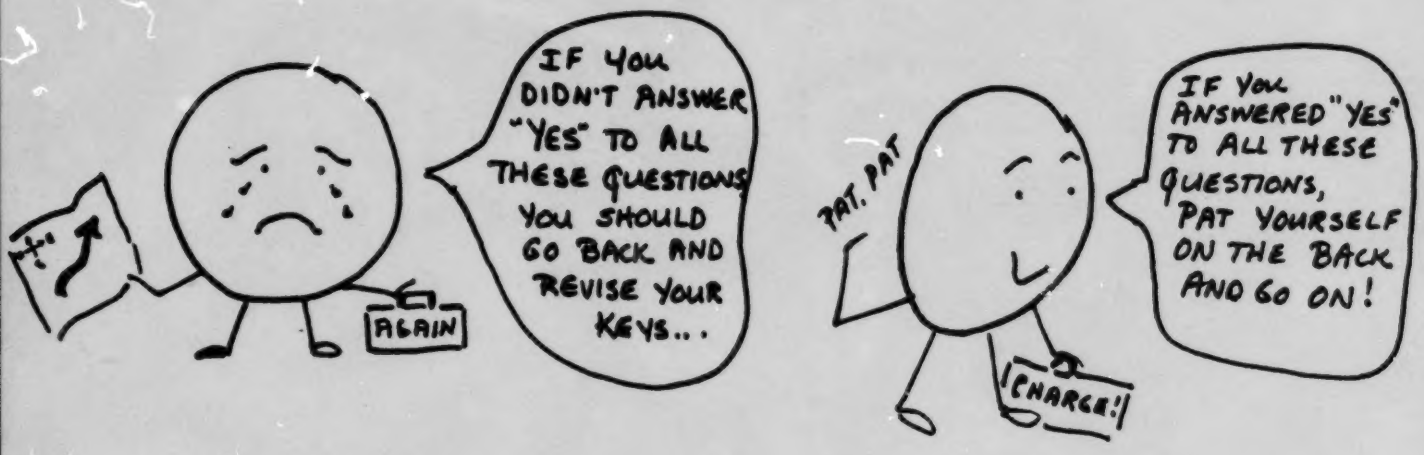


REMEMBER: The more ridiculous your Memory Key is, the easier it will be to remember. So let your imagination run wild!!



How did it go? Was it difficult to come up with good Keys? I hope you didn't get hung up trying to draw like Rembrandt. Before we find out if your keys work, please complete the table below.

	A (broncho)	B(rhino)	C(pilo)
1. Is your key visual			
2. Is it unusual?			
3. Does it include all the information to be memorized?			


IF YOU DIDN'T ANSWER "YES" TO ALL THESE QUESTIONS YOU SHOULD GO BACK AND REVISE YOUR KEYS...
AGAIN
PAT, PAT
IF YOU ANSWERED "YES" TO ALL THESE QUESTIONS, PAT YOURSELF ON THE BACK AND GO ON!
CHARGE!

PRACTICE CYCLE 3

Now, let's see if your Memory Keys work. If they do, you should be able to remember the definitions of each of these word roots.

Word Root	Meaning
A. rhino	_____
B. pilo	_____
C. broncho	_____

Look back to page 6 to see how you did. How many of the definitions did you remember? Did the mental pictures come back to you? Once you got the picture back, were you able to pull out the definition?

PRACTICE CYCLE 4

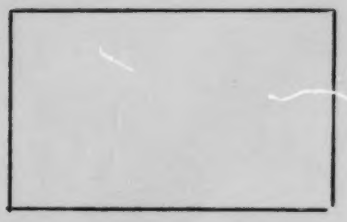
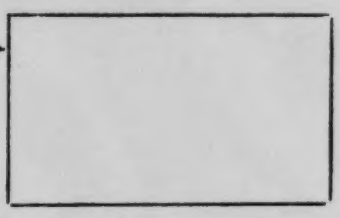
Now, let's see if you can use Memory Keys to learn some word roots when you are faced with a time limit. Before you run for the door, let me remind you that once you've thought of a good key, your work is over -- your mental picture will tell you all you need to know.

Before you start the exercise, I want to give you one more example. You may have noticed that some of these word roots are harder than others. Sometimes you really have to stretch your imagination to come up with a Memory Key. Sample D should illustrate my point.

Sample D	To be Memorized	Memory Key
	"dorsum" means "back"	

Sample D goes pretty far afield in order to include all the information, but by being so absurd, the Key becomes that much easier to remember. OK, now it's your turn. Allow yourself 5 minutes to draw your Keys.

Then we'll see how well they work:

To be Memorized	Memory Key
A. "angio" means "vessel"	
B. "manus" means "hand"	
C. "veno" means "vein"	
D. "tricho" means "hair" (rhymes with Psycho)	
E. "gnath" means "jaw"	

Now let's see if your keys help you remember.

Root	Meaning
a. tricho	
b. veno	
c. angio	
d. manus	
e. gnath	

Look back to page 9 to see how you did. How many definitions did you remember? Did the pressure of a time limit affect your performance? If so, did it help or hinder you?

Students often complain that they are able to memorize material for a test, but that they forget everything an hour later. Memory Keys should enable you to remember material for a long period of time, particularly if your visual images are unusual.

Just for fun, lets see if you can recall some word roots from earlier in the package.

Word Root	Meaning
A. "dorsum"	_____
B. _____	nose
C. "pilo"	_____
D. _____	tooth
E. "broncho"	_____

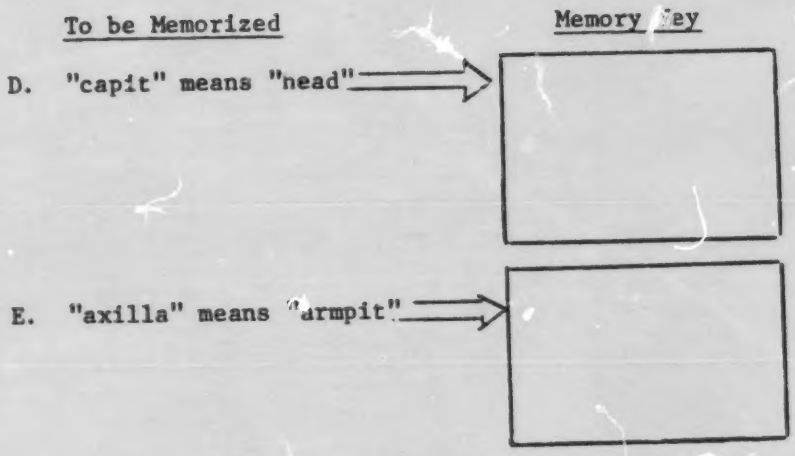
How many were you able to recall? Did you find that the most unusual mental images were the easiest to recall?

You have completed all the practice exercises in this package. All that remains is the post-test. If you are unclear about any of the material in the package, this would be a good time to look back over earlier sections. I hope you have had some fun with Memory Keys and that you will use them in the future.

POST-TEST

Allow yourself 5 minutes to draw Memory Keys for the word roots below. Then turn to page 13, and write as many of the definitions as you remember. Good luck!

To be Memorized	Memory Key
A. "bucca" means cheek" ⟹	
B. "frons" means "forehead" ⟹	
C. "arthro" means "joint" ⟹	


To be Memorized
Memory Key
D. "capit" means "head"
E. "axilla" means "armpit"

Now, let's see if your Keys help you remember.

Root	Meaning
A. axilla	
B. capit	
C. bucca	
D. frons	
E. arthro	

Turn back to page 11 to correct your post-test. How many were you able to remember? _____

Would you say that using Memory Keys increased, decreased, or did <u>not</u> change your ability to memorize?

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INTERPRETING READINGS OF SCIENTIFIC MEASURING SCALES IN THE DECIMAL MATHEMATIC SYSTEM

by

Charles Afflerbach

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TITLE OF PACKAGE:	Interpreting Readings of Scientific Measuring Scales in the Decimal System.
AUTHOR:	Charles Afflerbach
INSTITUTION:	El Centro College
INTENDED STUDENTS:	Any health career student
ESTIMATED WORKING TIME:	20 minutes
MATERIALS NEEDED:	None

FIELD TEST COPY

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OBJECTIVES OF UNIT

Overall Objective

The student will interpret divisions of scientific measuring scales in the decimal system by recording the correct value of selected scale readings.

Sub-Objectives

1. Define the terms "grided scale," "decimal system," and "scientific scale."
2. Locate and interpret the major unit and range of a "scientific scale."
3. Locate and interpret the reading of a "scientific scale" to the nearest tenth decimal place.
4. Locate and interpret the reading of a "scientific scale" to the nearest hundredth decimal place.

INTRODUCTION

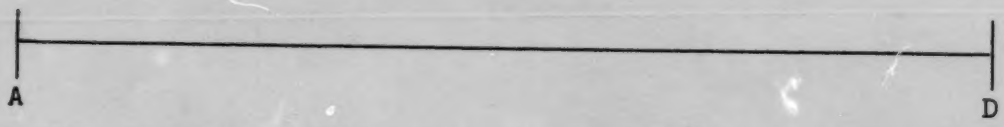
There is a continuous need for medical people to interpret various scientific measuring scales. Some specific units of measurement may be for mass in grams, for volume in liters, or for linear distance in meters.

The majority of scientific scales involve interpreting ruled or grided lines and equating a ruled area into the decimal system.

The purpose of this package is to show you how to read a grided scientific scale in the decimal system. Once you have mastered this, you will be able to equate the decimal system to any scientific unit such as grams, liters, meters, temperature, etc. Some common medical equipment that utilize scales in the decimal system are thermometers, spectrophotometers, pH meters, analytical balances, and sphygmomanometers.

PRACTICE EXERCISE #1

1. A "grided scale" is a linear or circular area composed of parallel lines that are equal distance from each other. The grided scale below is composed of two parallel lines at point "A" and point "D", each equal distance from each other.



2. The "decimal system" is a mathematical system that increases or decreases a number in multiples of ten.

   Example: .01, 0.1, 1, 10, 100, 1000, etc.

3. A "Scientific Scale" is a "grided scale" that has assessed numerical values. In the "Scientific Scale" below numerical values have been assessed to the scale at point A and point B.

In exercises (2) through (4) I will show you how to decrease the increments of a scale in multiples of ten, which is by definition the "decimal system." Consequently our "scientific scale" will be based on the "decimal system."

Practice Question #1

See if you can recall the definitions I gave you on the previous page without "peeping."

1) "Grided scale"

2) "Decimal system"

3) "Scientific scale"

Feedback

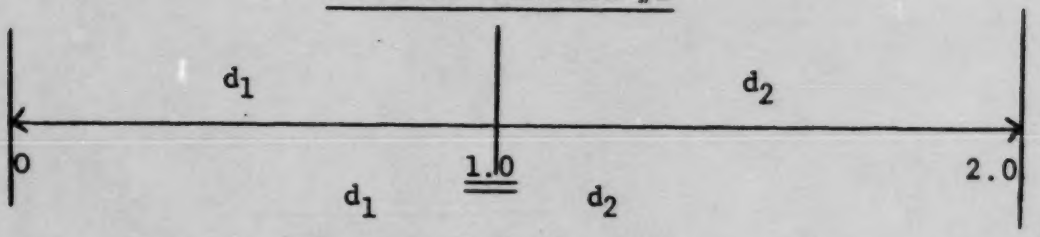
Were your answers similar to these?

1) A "grided scale" is a linear or circular area composed of parallel lines that are equal distance from each other.

2) The "decimal system" is a mathematical system that increases or decreases a number in increments of ten.

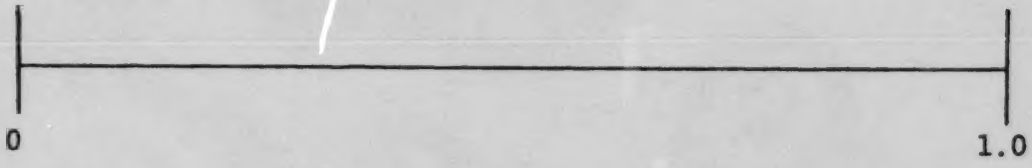
3) A "scientific scale" is a "grided scale" that has been assessed numerical valves usually based on the "decimal system."

PRACTICE EXERCISE #2



1. A "scientific scale" usually has many numbers on the grid that must be interpreted. Before progressing, let us consider the limitations of a scale. We may only interpret readings of a scale between the highest and lowest numbers on the scale; this is termed the range or numerical range of the scale. The range of the scale above is between 0 and 2.0.
2. Major units on a scientific scale are the largest decimal equivalent numbers and coincide with the longest parallel lines on the scale. The scale distance between major units are equal. In the example above, 1 and 2 are major units; zero is generally regarded as a reference or point of origin rather than a major unit. Major units are usually whole numbers.

Practice Question 2



1) Give the numerical range for the scale above.

2) What is the major unit in the scale above?

Feedback

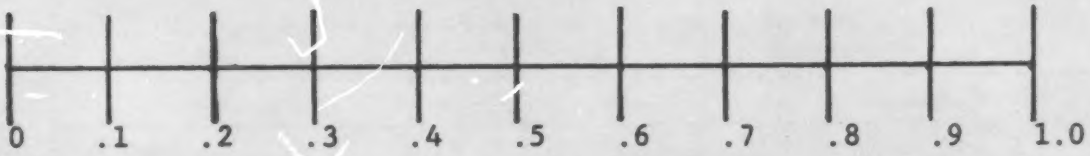
1) 0 to 1.0

2) 1.0

PRACTICE EXERCISE #3

Please go back to Practice Exercise #2 and observe the scale. You learned that the major unit of the scale is 1.0 or we may say between 0 and 1.0 is one unit. Utilizing the decimal system, we may decrease 1.0 unit into ten smaller units. Each small unit is now only 1/10 or 0.1 unit of the original 1.0 unit.

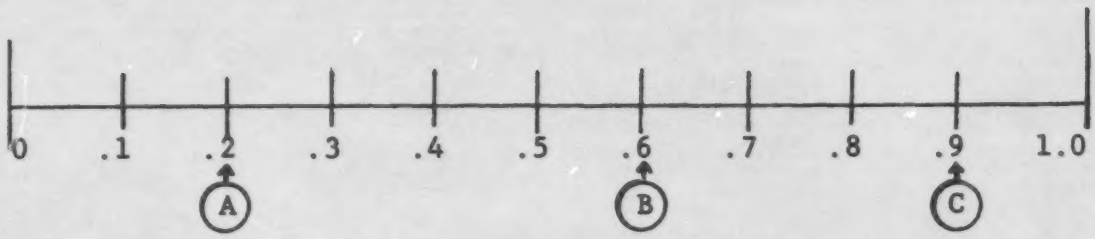
This fact may be illustrated below by dividing the scale into ten smaller grids. The ten parallel lines are shorter than the major units since they represent smaller units. Observe the illustration.



By definition of the decimal system, we have decreased our major unit into increments of 10, therefore each small line on the scale represents 0.1 of the major unit of the scale. If you were measuring the scale distance between 0 and 0.1; the scale reading would be 0.1 units. The distance between 0 and 0.2 equals a scale reading of 0.2 units. The distance between 0 to 0.3 equals a scale reading 0.3 units; etc.

PRACTICE EXERCISE #3

Practice Question #3



1) What is the scale reading at arrow A ?

2) What is the scale reading at arrow B ?

3) What is the scale reading at arrow C ?

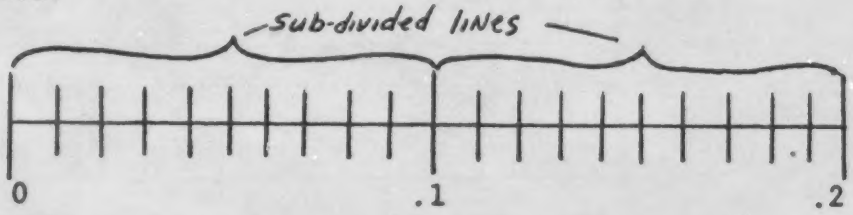
Feedback

Good going if you answered:1) 0.2 units; 2) 0.6 units; 3) 0.9 units

PRACTICE EXERCISE #4

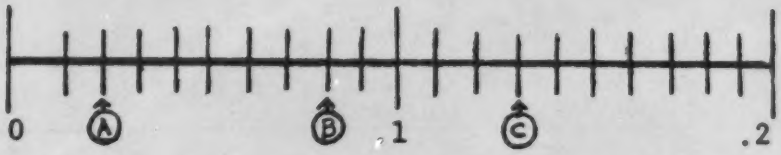
You have probably been wondering how many times ycu can subdivide divisions of a scale in the decimal system. The answer is indefinitely. However, most scales that you use will be to the hundredth or thousandth decimal place.

To illustrate this point, let's go back to our scale in Practice Exercise #3. You learned that the smallest unit that you could read on the scale is one-tenth units. Utilizing the decimal system, we may subdivide the tenth unit scales into ten more smaller grided lines. This is the area between 0 and 0.1, 0.1 and 0.2, 0.2 and 0.3; etc. We have decreased the tenth decimal place into increments of ten; therefore, the smallest lines on the scale now read to the hundredth decimal place. This will be fully understood if you examine the scale below that has been enlarged in the range of 0 to 0.2 units.



11

Note that each sub-divided line on the grid represents the hundredth decimal place like one hundredth (.01), two hundredth (.02), three hundredth (.03), etc. When reading scale units between 0.1 and 0.2, 0.2 and 0.3, etc. You must consider both the tenth and hundredth decimal place. The following distances from 0 to points A , B , and C represent some typical scale readings in the decimal system.



Arrow Ⓐ = two-hundredth (.02)

Arrow Ⓑ = eight-hundredth (.08)

Arrow Ⓒ = thirteen-hundredth (.13)

Practice Question - #4

1) What is the scale reading at arrow Ⓐ ?

2) What is the scale reading at arrow Ⓑ ?

3) What is the scale reading at arrow Ⓒ ?

Feedback

You are doing very good if you answered:

1) .06 units

2) .39 units

3) .82 units

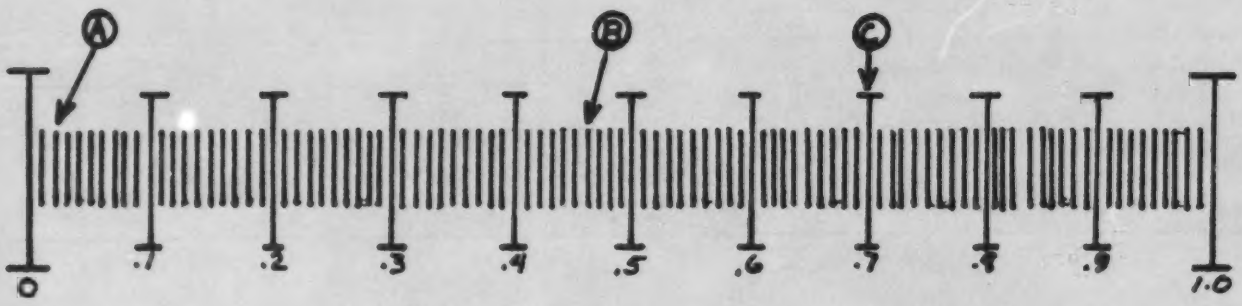
POST-TEST

1. Write down the meaning of the following terms:

   grided scale:

   decimal system:

   scientific scale:



2. Record the value of the major unit in the scale above.
3. Record the value of the scale above at arrow "A."
4. Record the value of the scale above at arrow "B."
5. Record the value of the scale above at arrow "C."

ANSWERS TO POST-TEST

1. Grided scale - a linear or circular area composed of parallel lines that are equal distances apart.
   decimal system - a mathematical system composed of numbers that differ from each other in multiples of ten.
   scientific scale - a grided scale that has been assessed numerical values.
2. 1.0
3. .02
4. .46
5. 0.7

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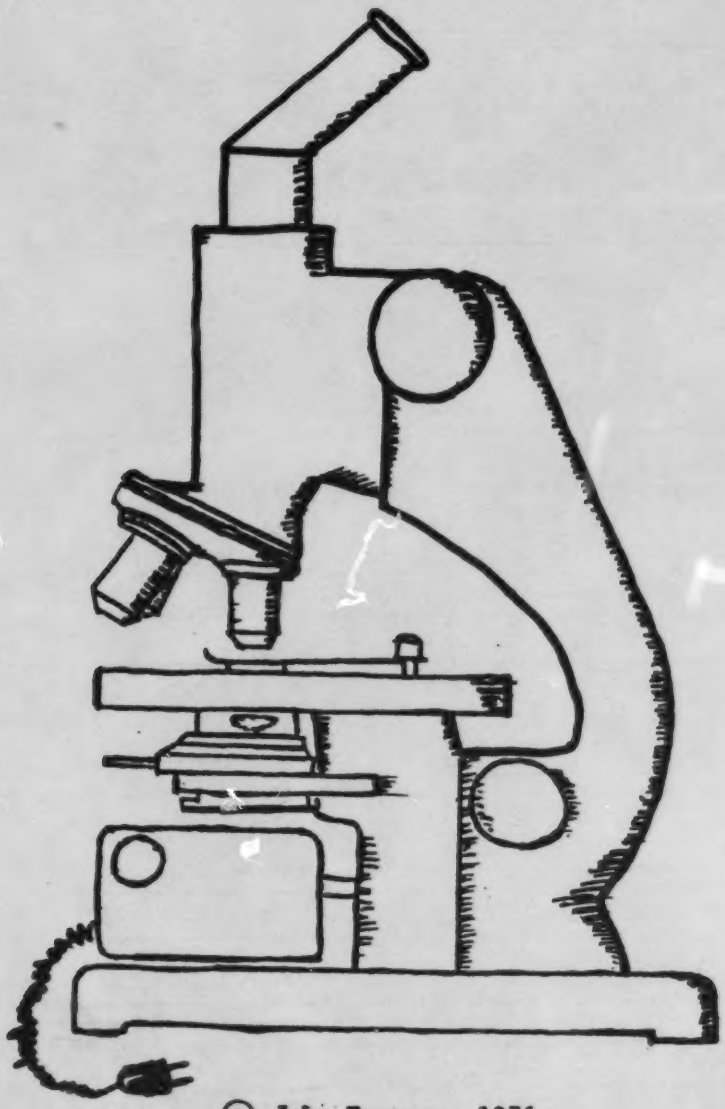
HOW TO USE THE LIGHT MICROSCOPE

By

John Ferrara



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TITLE OF PACKAGE:	How To Use The Light Microscope
AUTHOR:	John Ferrara
INSTITUTION:	Cuyahoga Community College, Cleveland, Ohio
INTENDED STUDENTS:	Beginning biology
ESTIMATED WORKING TIME:	30 minutes
MATERIALS NEEDED:	Light microscope (Bausch & Lomb IST); Slide box with a slide of letter "e" and a test slide x with an unknown letter on it.

FIELD TEST COPY

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INTRODUCTION

The light microscope is one of the most important tools used in all the fields that relate to the biological sciences. It is an easy instrument to learn how to use and will be of value to you as you pursue the biological world to your own personal extent.

For a brief history about the development of microscopes you might wish to consult your textbook or almost any biology book in the library.

For this exercise you will be provided with a microscope and a slide box.

OBJECTIVES OF UNIT

Overall Objective

Students who complete this instructional unit will be able to effectively use the compound light microscope.

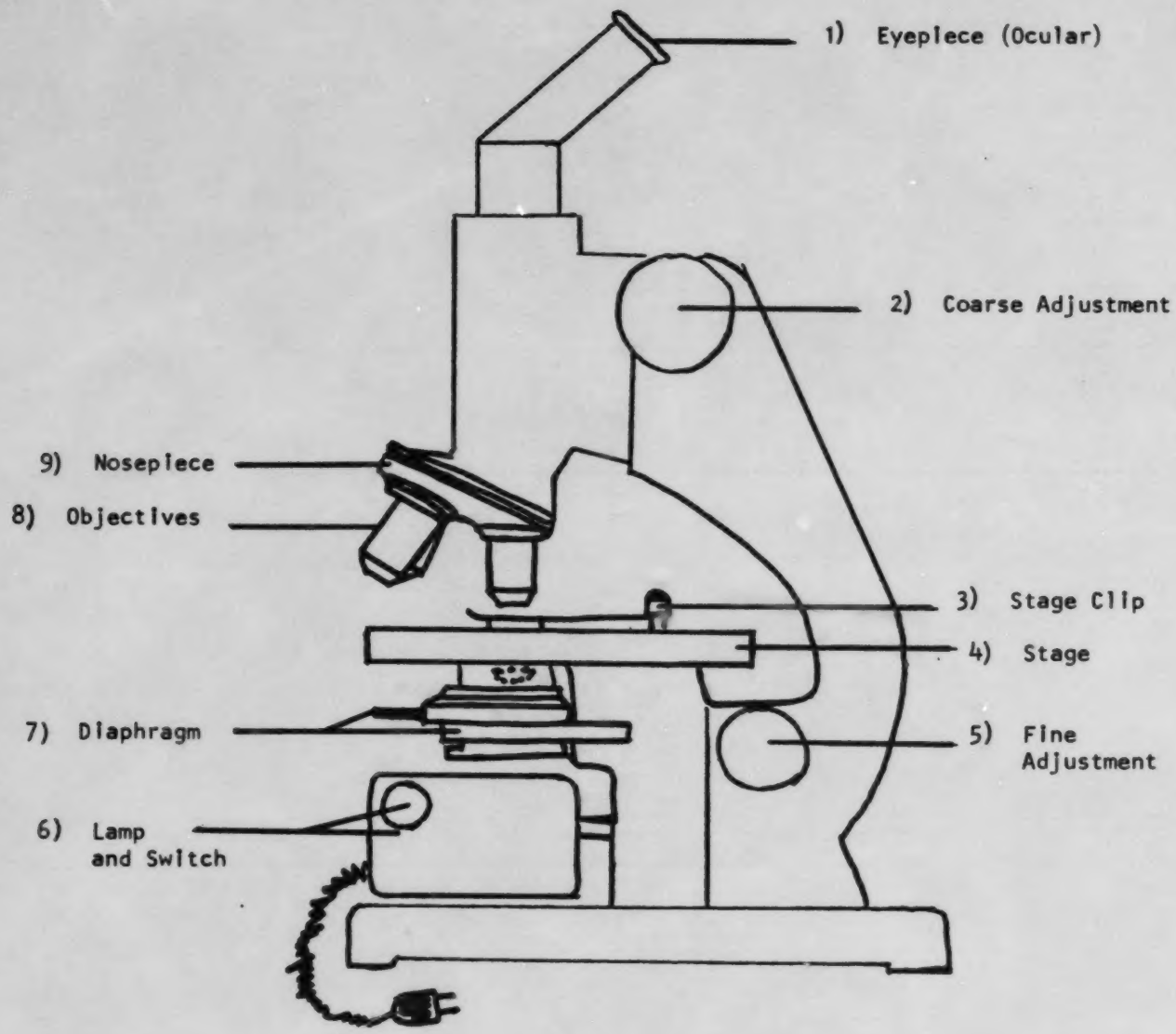
Sub-Objectives

1. Name the parts of the microscope.
2. Predict the functions of the parts of the microscope.
3. Place a slide under the microscope.
4. Focus on the slide with the scanning objective using the coarse adjustment.
5. Focus on the slide with the low power objective using the coarse adjustment.
6. Focus on the slide with the high power objective using the fine adjustment.

PRACTICE EXERCISE #1

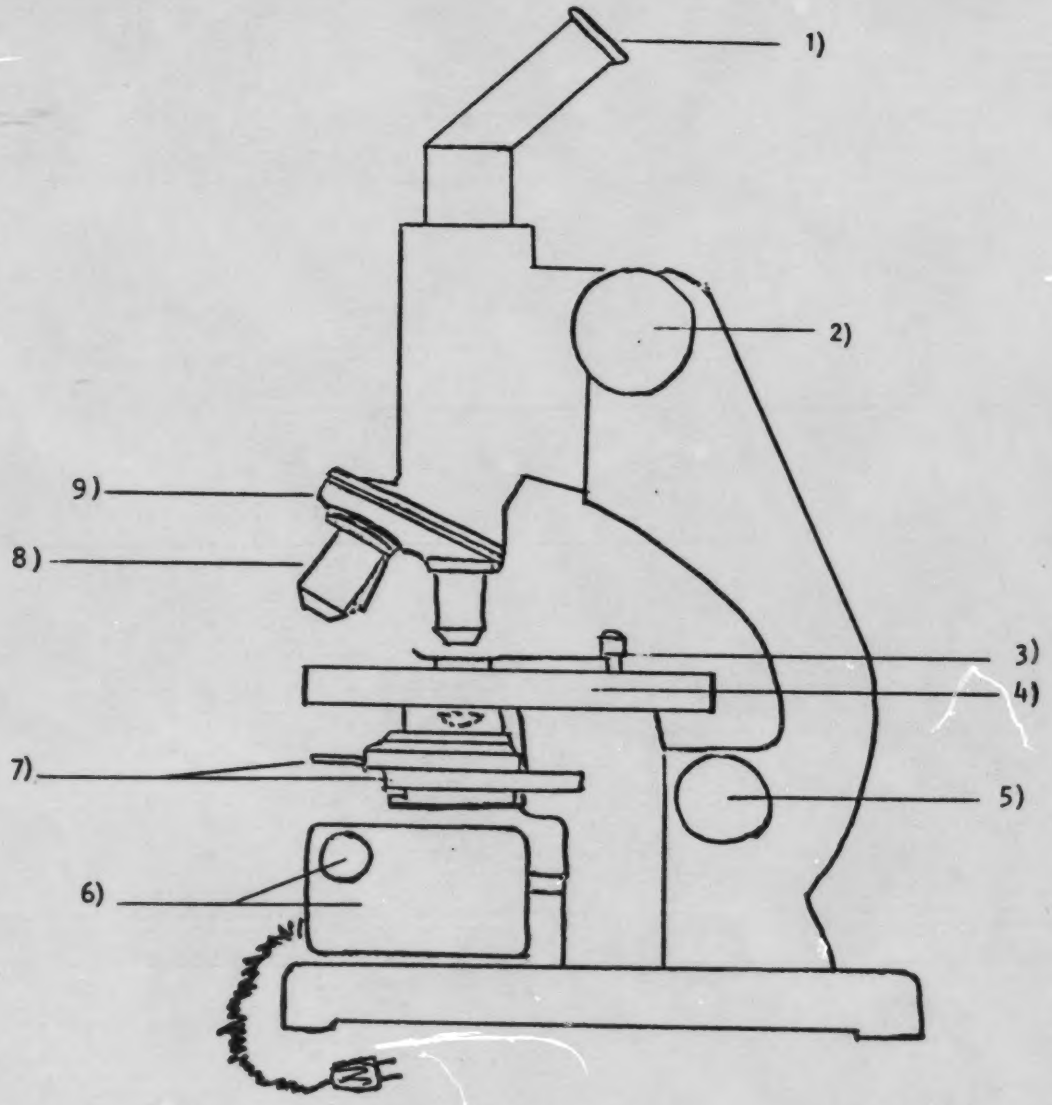
Input

Remove the plastic dust cover and plug in the microscope light source. Find the required parts of the microscope in front of you by using this labeled diagram.



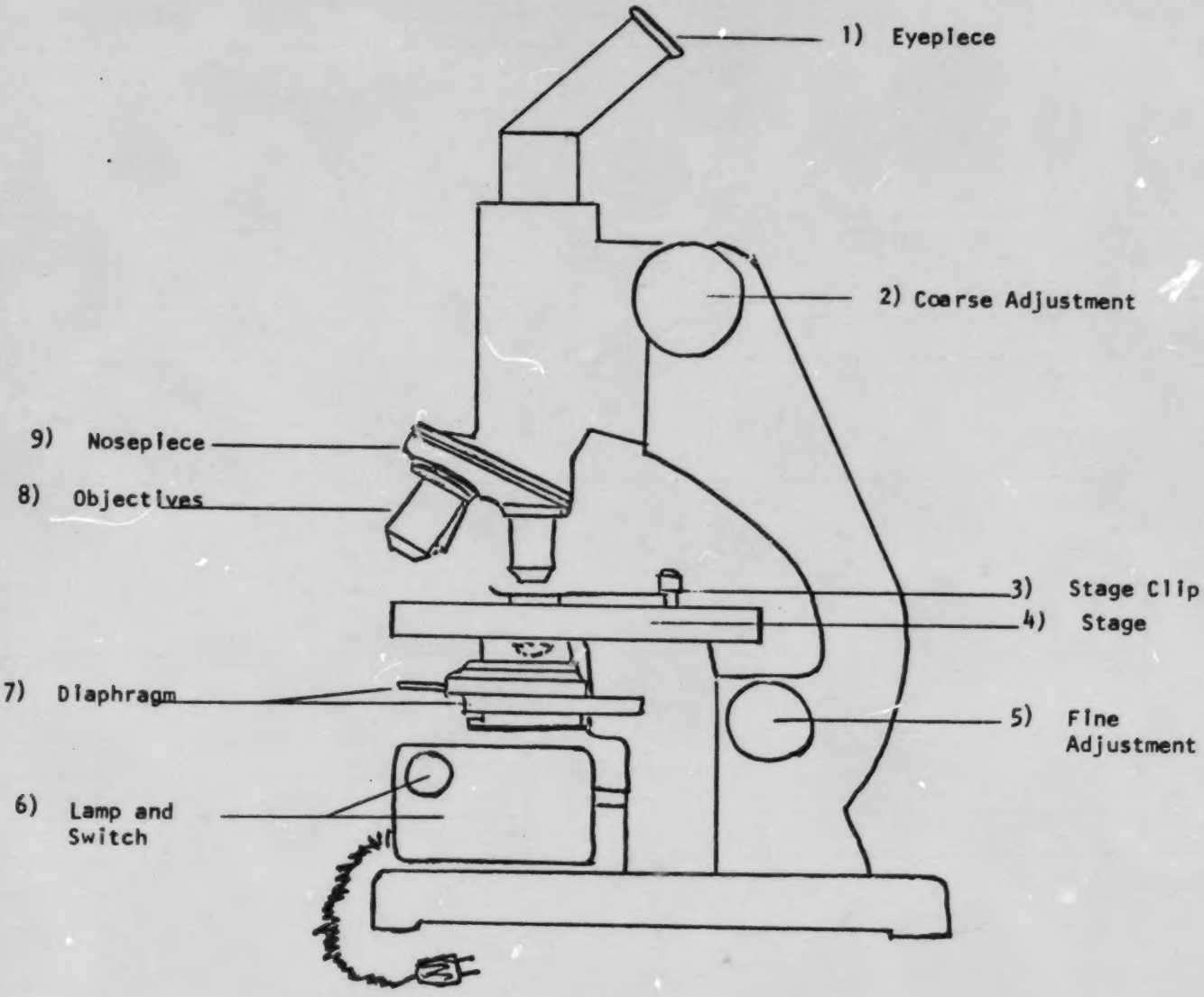
Practice Question #1

Label the parts of the microscope on the diagram provided.



Feedback

This is a properly labeled diagram of the microscope. If you have all the labels correct, that is excellent. If not, you will soon know them by continuing on in this exercise.



PRACTICE EXERCISE #2

Input

Each part of the microscope has an important function that will make the microscope work for you. The parts and their functions are listed below. As you read over each part and its function, find the part on the microscope using the diagram on page 5.

Lamp and switch - light source

Diaphragm - controls the amount of light that strikes the microscope slide. The amount of light is increased or decreased by moving the lever on the diaphragm to the left or right.

Stage - where microscope slide is placed

Stage clips - hold slide in place

Nose piece - holds the objectives

Objectives - part of the magnification lens system. Scanning objective has a blue ring around it. Low power objective has a green ring around it. High power objective has a yellow ring around it.

Eyepiece (Ocular) - part of the magnification lens system

Coarse adjustment - used for focus with scanning objective or low power objective. Never used with high power.

Fine adjustment - used for focus with high power objective

Practice Question #2

Below is an alphabetical list of the microscope parts. Covering the top of this page, write the function for each part.

1) Coarse adjustment -

2) Diaphragm -

3) Eyepiece (ocular) -

4) Fine adjustment -

5) Lamp and switch -

6) Nosepiece -

7) Objectives -

8) Stage -

9) Stage clips -

Feedback

You will become more familiar with these as you use the microscope.
Check your answers below.

Coarse adjustment - used for focus with scanning and low power objectives.

Diaphragm - controls amount of light that passes through the slide.

Eyepiece (Ocular) - part of magnification lens system.

Fine adjustment - used for focus with high power objective.

Lamp and switch - source.

Nosepiece - holds objective lenses.

Objectives - part of magnification lens system.

Stage - place where slide is placed.

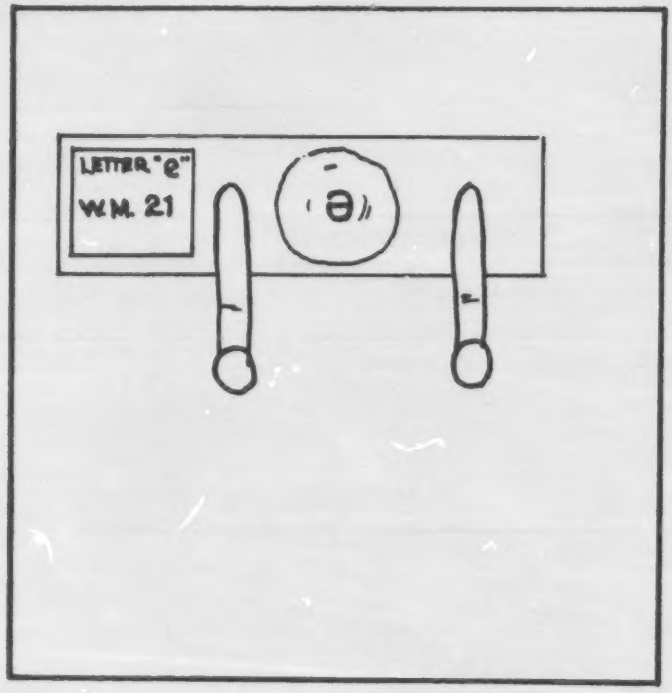
Stage clips - hold slide in place.

PRACTICE EXERCISE #3

Input

Find the switch on the left hand side of the light source and turn the light on. You will also find it helpful if you move the lever near the front of the diaphragm all the way to your left.

Remove the letter "e" slide from the slide box. Place it on the stage over the stage hole so that the part of the slide with the letter "e" is in the center of the hole as shown in the diagram below and put the clips in place. Turn the objectives on the nosepiece until the scanning lens (blue ring) "snaps" in place nearest you. Run the lens down as far as you can by



turning the coarse adjustment away from you. Now look into the eyepiece and slowly turn the coarse adjustment towards you until the image of the letter "e" is in focus. It may be necessary to move the slide until the "e" is in the center of the field of vision.

Practice Question #3

Can you see the whole letter "e" in the field of view with the scanning objective? (Yes or No)

Feedback

If you answered "yes" then you positioned the slide correctly. If you answered "no", simply reset the slide and observe it again. It may take a little practice, but you will soon be proficient. Always move the slide so

that the image is in the center of the field of view. This way when you switch to a higher power, the image will still be in the center.

PRACTICE EXERCISE #4

Input

Next turn the objectives on the nosepiece until the low power objective (green ring) "snaps" into place nearest you. You will see that the letter "e" is relatively in focus. You may need only make a small adjustment with the coarse adjustment to bring the image into sharp focus. Microscopes that allow you to switch from objective to objective and still be in relative focus are called parfocal.

Practice Question #4

Can you see the whole letter "e" in the field of view with the low power objective? (Yes or No)

Feedback

If you answered "yes" then you positioned the slide correctly. If you answered "no", simply reset the slide.

PRACTICE EXERCISE #5

Input

While still using the low power objective, gently push the slide with your left hand towards your right. Microscope lenses reverse all movements you will make with the slide.

Practice Question #5

Which way does the image your eye receives appear to move when you push with your left hand? (Right or Left)

Feedback

You should have answered "left". Remember that microscope lenses reverse all movements. It is awkward at first, but you will get used to it.

PRACTICE EXERCISE #6

Input

Return the letter "e" to the center of the field of vision.. Now turn the objective lenses in the nosepiece until the high power objective (yellow ring) "snaps" into place nearest you. This time make any final adjustment to bring the image into sharp focus with the fine adjustment. At this point you may need to move the diaphragm lever to your right slightly in order to allow more light to pass into the microscope.

Practice Question #6

Can you see the whole letter "e" in the field of view with the high power objective? (Yes or No)

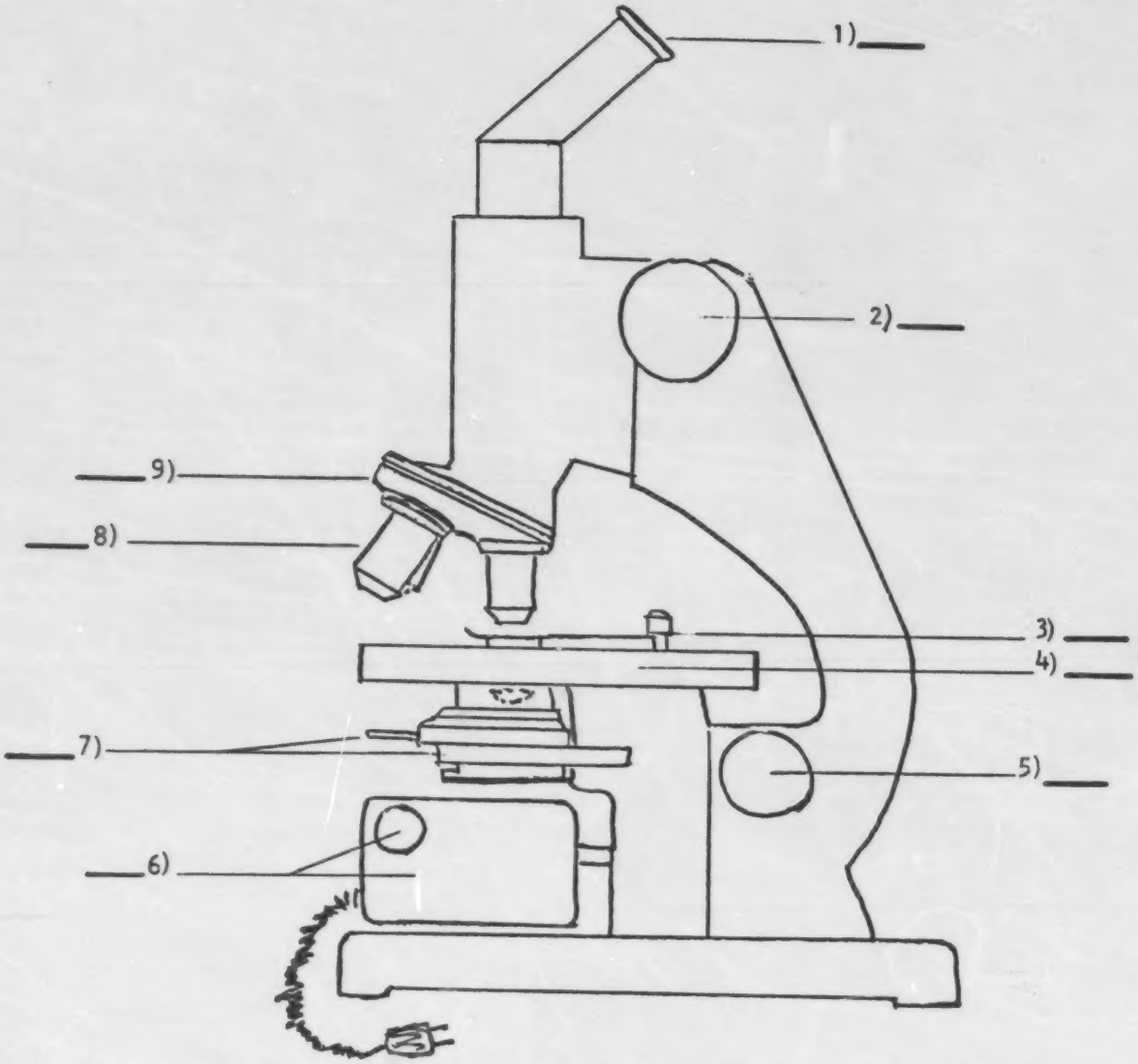
Feedback

You should only see a part of the letter "e" because you have increased the magnification to a large degree. Note how the individual fibers of the newspaper can now be seen.

Return the objectives to the scanning lens and remove the slide, placing it in the slide box. Go on to the post-test.

POST-TEST

1. Listed below the diagram are the required parts of the microscope. Match this list to the microscope on the spaces provided.



A. Coarse adjustment
B. Diaphragm
C. Eyepiece (Ocular)
D. Fine adjustment
E. Lamp and switch
F. Nosepiece
G. Objectives
H. Stage
I. Stage clips

2. Match the parts of the microscope with their correct function.

Parts	Functions
____ Coarse adjustment	A. Light source
____ Diaphragm	B. Controls amount of light
____ Eyepiece (Ocular)	C. Where slide is placed
____ Fine adjustment	D. Holds slide on stage
____ Lamp and switch	E. Holds objective lenses
____ Nosepiece	F. (Used twice) Part of magnification lens system
____ Objectives	G. Focus with scanning and low power objectives
____ Stage	H. Focus with high power objective
____ Stage clips	

3. Take Test Slide X out of the slide box, place it correctly on the stage, clip it down, and focus under low power. If you do this correctly, what letter do you see?

4. Now push Test Slide X with your right hand to the left. Which way does the image appear to be moving?

5. Now push Test Slide X away from you. Which way does the image appear to be moving?

6. How do you account for the apparent movements that occur in questions 4 and 5?

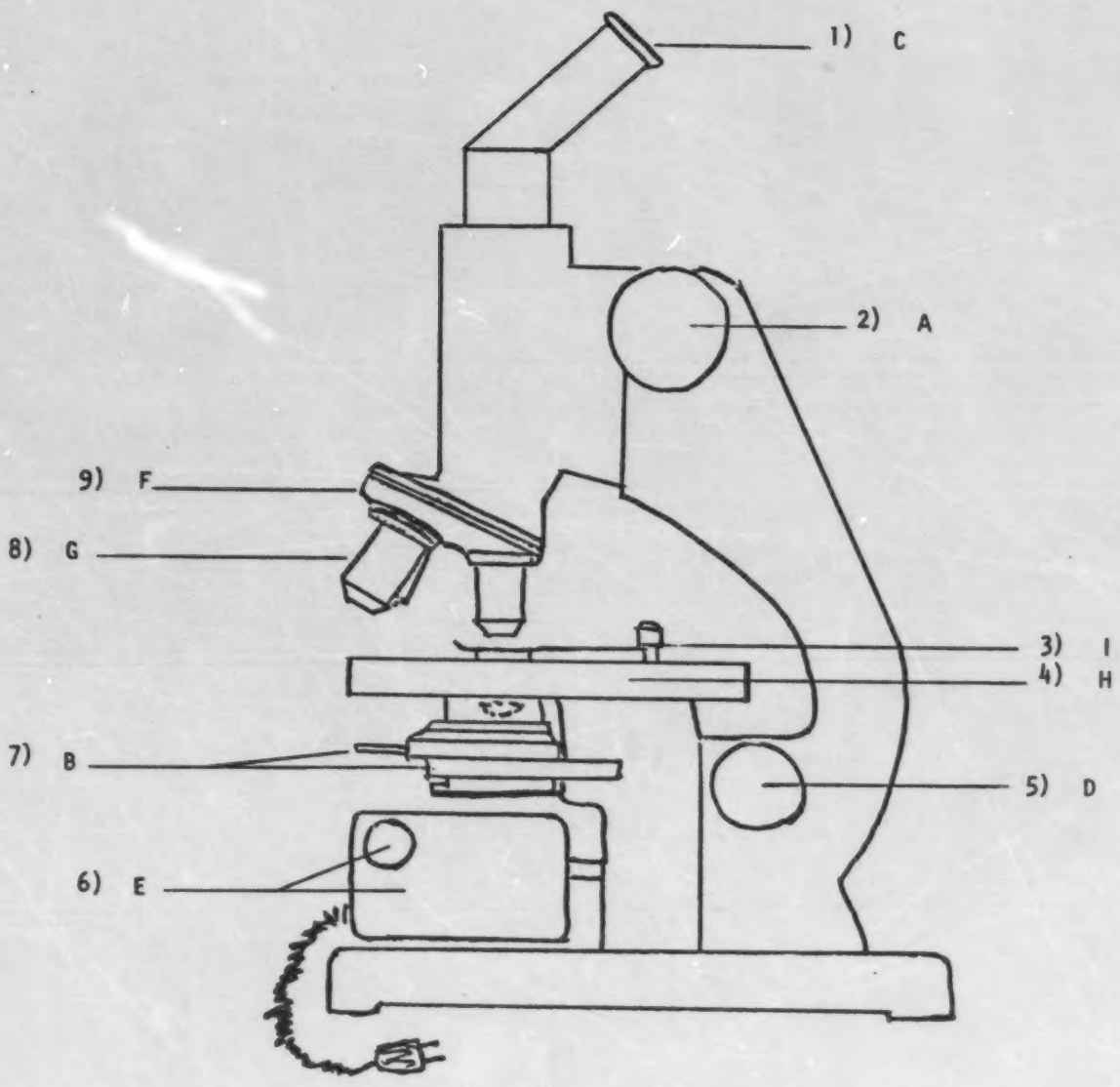
7. Return the image to the center of the field of view. Now switch to the high power objective. What happened to the image when you switched to the high power objective?

8. When you switch to high power, is the image in relative focus? Why or why not?

When completed, return to the scanning lens, remove the slide and place it in the box, unplug the light, wrap up the cord, and replace the dust cover. Thank you for your assistance.

POST-TEST ANSWER KEY

1.



2. G Coarse adjustment

   B Diaphragm

   F Eyepiece (Ocular)

   H Fine adjustment

   A Lamp and switch

   E Nosepiece

   F Objectives

   C Stage

   D Stage clips

3. "a"

4. To the right.

5. Toward you.

6. Lenses reverse all movements.

7. The image was magnified so only part of it is visible.

8. Yes. This is a parfocal microscope.

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INTRODUCTION TO THE STETHOSCOPE

TECHNIQUES AND PROCEDURES FOR AUSCULTATION OF THE CHEST

by

William J. Boykin, R.R.T.

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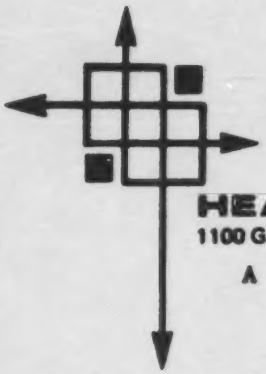
TITLE OF PACKAGE:	Introduction to the Stethoscope, Techniques and Procedures for Auscultation of the Chest
AUTHOR:	William J. Boykin, R.R.T.
INSTITUTION:	Loma Linda University Medical Center
INTENDED STUDENTS:	Allied Health Students
ESTIMATED WORKING TIME:	20 minutes
MATERIALS NEEDED:	Stethoscope

FIELD TEST COPY

Note: Student will need the help of two other persons for the Post-Test at the end of this unit.



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INTRODUCTION

Hi! This instructional packet is going to prepare you to use the stethoscope for listening to a person's chest, or more specifically, his lungs.

The stethoscope has a variety of uses in the medical profession from listening to sounds in the abdomen (stomach) and lungs to taking a blood pressure. In this package we will be concerned with the chest (lungs) or breath sounds.

Your ability to use the stethoscope, and use it correctly, is of vital importance to the patients you are treating and caring for. It will give you the ability to assess your patient's respiratory status, often in advance of impending complications. This package will only prepare you for this.

The packages to follow will improve your skills and expertise in auscultation of the lungs.

OBJECTIVES OF UNIT

Overall Objective

At the end of this study packet the participant will be able to demonstrate the ability to apply the correct techniques and procedures for ausculatation of the chest.

Sub-Objectives

1. Describe the primary purpose of the stethoscope.
2. Given a stethoscope, identify the following parts: head-piece, bell chest-piece, diaphragm, tubing and earpiece.
3. Differentiate between the types of sounds heard with the bell chest-piece and diaphragm.
4. Given a description of a case presentation, differentiate between descriptions of erroneous sounds heard on auscultation that may be due to improper technique.
5. Given a simulated situation, instruct the patient in the four procedures necessary for proper auscultation of the chest.

NOTE: Prior to beginning this package, take the Stethoscope and look at it, play with it, take it apart, and put in back together. Now, proceed to Practice Exercise #1.

PRACTICE EXERCISE #1

The stethoscope is the instrument or tool commonly used for auscultation or listening to sounds in the chest. The primary purpose of the stethoscope in this study package is to identify normal or abnormal conditions that may be present in the chest. The type we normally use is called a binaural stethoscope, meaning we have an earpiece for each ear. There is another type called a monaural which is commonly used by anesthesiologists.

Briefly describe the primary purpose of the stethoscope.

PRACTICE EXERCISE #1 (continued)

Feedback

If you answered "An instrument or tool used to identify a normal or abnormal condition that may be present in the chest," you're RIGHT.

If not, review the previous section and write it down on paper and then proceed.

PRACTICE EXERCISE #2

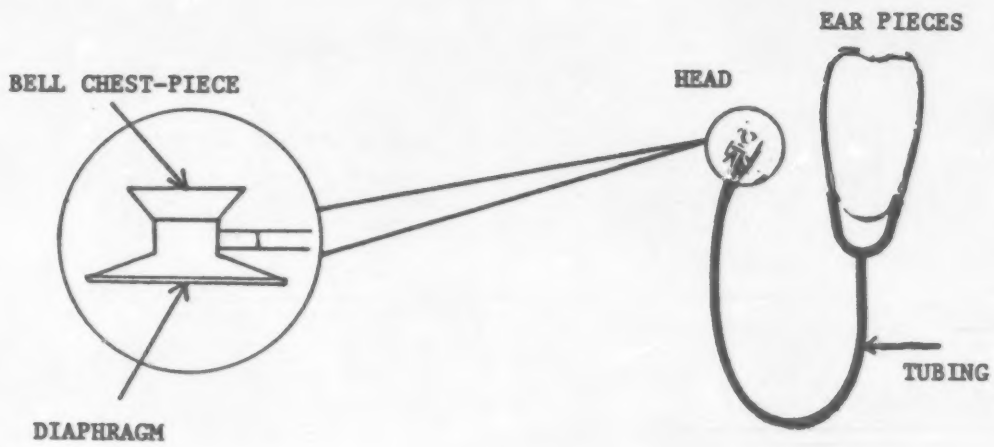
Now that we know the purpose of the stethoscope we can continue on and identify the components we commonly use. These include:

a. Earpiece

b. Tubing

c. Bell chest-piece

d. Diaphragm



PRACTICE EXERCISE #2 (continued)

In the diagram, which component part of the stethoscope is missing?

Feedback

I hope you answered the head. If you did, you are now able to identify the basic parts of the stethoscope.

If you were unable to identify the missing piece, perhaps you should review the components of the stethoscope once more before continuing.

PRACTICE EXERCISE #3

In the previous diagram, notice the head of the stethoscope is composed of the bell chest-piece and diaphragm. These two components have specific uses. The bell chest-piece will transmit all sounds in the chest. It is particularly valuable when listening for low-pitched sounds, e.g. heart sounds. It is also convenient for listening to the apices of the lungs (portion of lung just below collar bone) and between the ribs of thin patients (due to its smaller size). The bell chest-piece should be pressed lightly against the chest since the lower-pitched sounds would be filtered out if too firm a pressure were used.

In contrast to the bell chest-piece, the diaphragm piece filters out the low-pitched sounds enabling us to hear the higher-pitched sounds more clearly. These are the sounds we are primarily interested in when auscultating the lungs and examining the chest. The diaphragm piece, unlike the bell chest-piece, should be pressed firmly against the chest. This will minimize the number of external sounds picked up.

List the characteristic types of sounds heard with the two components below:

a. Bell chest-piece

b. Diaphragm

c. What portion of the stethoscope do these two components comprise?

PRACTICE EXERCISE #3 (continued)

Feedback

Check below and see if you were able to identify the different types of characteristic sounds we use the "HEAD" of the stethoscope for.

Bell chest-piece	Diaphragm
1. all sounds within the chest	1. higher-pitched sounds
2. low-pitched sounds (e.g. heart sounds)	(e.g. lungs)

If you were not sure of the types of characteristic sounds we use the bell chest-piece and diaphragm for, please review and get them straight. Then proceed on to the next exercise.

PRACTICE EXERCISE #4

Now that you have the stethoscope down pat and can identify the types of sounds we listen to with the bell chest-piece and diaphragm, the next step is to recognize the common errors we generally make when auscultating. There are basically four:

1. Breathing on the tube of the stethoscope--which gives a very loud coarse hollow sound. We typically hear this sound on patients with a consolidative process within the lung (e.g. pneumonia). If you hear this, observe your position and make sure you are not breathing on the tubing. Often we have to lean over the patient in such a way that causes this error to occur.
2. The second type is artifact produced by chest hair against the diaphragm--commonly heard on men with a lot of chest hair. This will produce fine crackling sounds we often associate with diseases such as pulmonary edema (fluid in the lungs). To correct this problem you need to press the head of the stethoscope a little more firmly against the chest.
3. The third error is using a cracked or malfitted diaphragm. This will also produce a crackling sound which we may mistake for an infiltrative process (e.g. pneumonia). It is good practice to always check the diaphragm of the stethoscope to insure it is tight and not cracked, especially if these sounds are heard.
4. The last common error is muscle twitching, which again can lead us to believe there is an infiltrate (e.g. pneumonia) present. However, this error is easier to identify since we can usually observe the muscle twitching of the patient.

PRACTICE EXERCISE #4 (continued)

Before answering the following question, summarize the four common errors in auscultation --- then proceed to the case presentation.

A 30-year-old male patient complaining of acute pain in the left upper quadrant (just below the last rib on the left, anteriorly) is admitted to the unit in which you are working. Since the intern and resident are not available you are asked to do a chest exam and auscultate the lungs. The patient does not appear to be in any respiratory distress and denies having any problem breathing. After viewing the chest films you decide there are no infiltrates or abnormal densities (eg...tumors) present. However on auscultation of the right and left upper and middle lobes anteriorly (front of patient) you notice fine crackling sounds.

a. List three observations you might make about this case.

b. List three errors in technique or procedure that might cause the discrepancy in the breath sounds.

PRACTICE EXERCISE #4 (continued)

Feedback

If you noticed that:

1) This was a male patient
2) The patient did not present any definite respiratory problems or complaints
3) Had what appeared to be a normal chest x-ray

FANTASTIC! Good observation. If you answered the probable cause of the crackling sounds was due to:

1) Hair on the patient's chest (from not pressing on the diaphragm firmly enough)
2) Loose diaphragm
3) Cracked diaphragm

You hit it right on the nose--CONGRATULATIONS.

If you missed any of these points I suggest you review the section very carefully since it is essential for you to be aware of the possible errors. Then continue to the next exercise.

PRACTICE EXERCISE #5

For the last exercise we'll put together some of the information learned from the previous exercises and get you into using the stethoscope on the patient.

There are basically four procedures the patient needs to be instructed in to aid us in assessing the sounds we hear. First of all, the patient should be seated in a relaxed sitting position (if possible) with the shoulders drooped slightly forward. This moves the scapulae anteriorly (forward), exposing more lung area. This also spreads the muscle over a larger area which enhances the amplitude (loudness) of the sounds.

Secondly, the patient should be instructed to breathe a little deeper than normal. This causes more air to be moved into and out of the lungs, thus using more lung tissue and increasing the amplitude.

Thirdly, the patient should breathe through his mouth rather than his nose since the nose offers more turbulence to airflow, especially when deeper breaths are taken. This deep breathing will often produce highpitched sounds which are difficult to differentiate as being artifact (abnormal).

Finally, you should instruct the patient to inhale actively and exhale passively in a relaxed manner. By having the patient breathe in this fashion we are able to hear the inspiratory (inhalation) sounds more vividly and distinctly. The inspiratory phase is the phase we generally are able to identify abnormal disease processes in. Generally during exhalation we do not hear a significant amount of breath sounds to speak of. If we do, then we should suspect an abnormality. These are the procedures the patient must be instructed in. If you do not instruct the patient, then you will not be able to adequately assess the patient's breath sounds.

PRACTICE EXERCISE #5 (continued)

Grab a fellow student and practice the procedures and techniques discussed in this exercise for auscultating the lungs. When you are satisfied with your performance have a third student observe you and fill out the checklist provided on page 20.

Briefly review the four procedures you will instruct the patient in prior to auscultating. Then proceed on to the last paragraph.

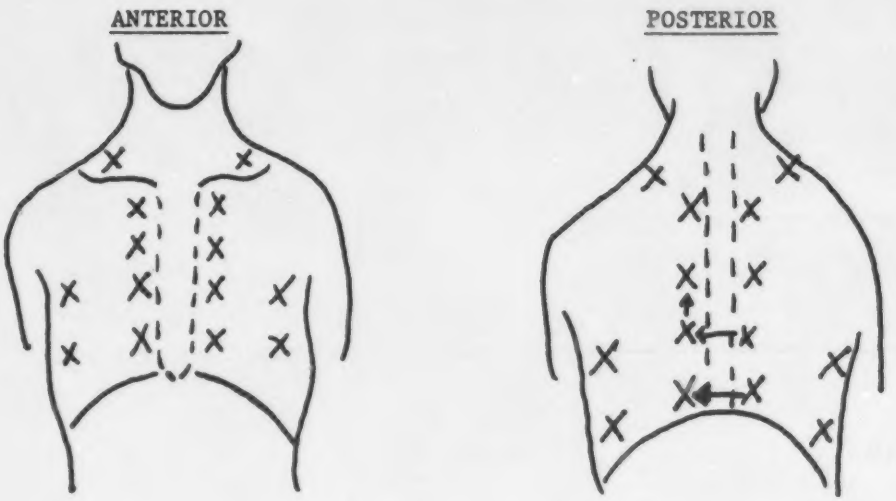
The actual act of auscultation is performed in a very simple and systematic way. We generally start posteriorly (patient's back) at the base of the lung. (The base of the lung can be identified by locating the last rib.) Place the diaphragm piece of the stethoscope adjacent to the spine and listen with your stethoscope. Then go to the same spot on the other side of the spine.

Proceed on up the back going from side to side having the patient breathe as previously instructed. Cover the entire back in this manner, continually moving laterally (around to the side).

PRACTICE EXERCISE #5 (continued)

When you reach the shoulder blades (scapulae), auscultate between them, again, on both sides and between the shoulder and the neck, just behind (posteriorly to) the collar bone. Now proceed in the same fashion only aneriorly (front), more or less following the rib cage and using the sternum (breast bone) as the center divider.

Review the diagram below:



X's indicate points auscultated ---------- EXAMPLE

PRACTICE EXERCISE #5 (continued)

CHECKLIST	YES	NO
1) Patient in correct body position.	___	___
a. sitting in relaxed position		
b. shoulders drooped slightly forward		
2) Patient instructed to breathe slightly deeper than normal.	___	___
3) Patient instructed to breathe through mouth.	___	___
4) Patient instructed to breathe actively on inspiration and passively on exhalation.	___	___
5) Uses systematic approach for auscultation.	___	___
a. progresses up or down the chest anteriorly and posteriorly comparing right side to left side or vice versa.		

If you were able to perform this chest exam without any errors you have done a superb assessment of this patient. CONGRATULATIONS! You are now ready to take the Post-Test. GOOD LUCK!

If you did not instruct the patient in the above techniques and procedures or performed your auscultation in some other manner, please review the exercise, practice a little more and give it another try. Above all, don't get discouraged. It take time to learn these procedures and techniques proficiently.

POST-TEST

1. Instructions: After reading the following case presentation, answer the question at the bottom of page.

A 55-year-old female patient is admitted to the emergency room complaining of a dull aching pain radiating up her left arm, shoulder and left mid-chest. The chest x-rays reveal both lungs to be clear anteriorly and posteriorly. The patient states she is not short of breath and denies any respiratory complaints other than the pain in the left chest. Upon auscultating the lungs you notice the breath sounds to be clear anteriorly. However, on posterior auscultation you hear a loud coarse hollow sound as the patient breathes (referred to bronchial breath sounds and associated with an abnormal condition in the lungs).

From this data in this case presentation:

a. List three observations you might make about the patient.

b. What error in technique might be contributing to the discrepancy in breath sounds?

Feedback

If you noticed that:

1) This was a female patient

2) Complained of no breathing problems

3) Had clear lungs according to the x-rays

You've done your lessons well and are very observant.

For the answer to the question: The coarse loud hollow sound that appeared to be abnormal breath sounds was most likely due to the technique in auscultation. The "auscultator" was breathing on the tubing of the stethoscope which sounds very much like the sounds described.

If you were able to assimilate this data and derive this answer from it, or were able to identify the answer initially, you should be very pleased with yourself.

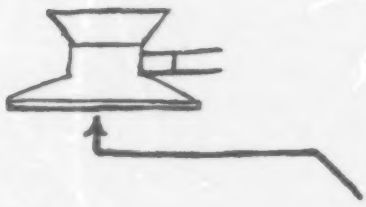
You are now ready to complete the remainder of the Post-Test.

PROCEED TO THE NEXT PAGE AND FOLLOW THE INSTRUCTIONS PROVIDED.....

2. As a practice exercise, visualize yourself having been called to a unit in the hospital to listen to a patient's chest. Demonstrate the procedures and techniques you would use to correctly assess this patient's lungs.

Instructions: Hand the checklist to one of the individuals who will assist you with the Post-Test. This person will assess your ability as you use the stethoscope to auscultate the other person.

CHECKLIST	YES	NO
1) Patient in correct body position:	___	___
a. sitting in relaxed position		
b. shoulders drooping slightly forward		
2) Patient instructed to breathe a little deeper than normal.	___	___
3) Patient instructed to breathe through mouth.	___	___
4) Patient instructed to breathe actively on inspiration and passively on exhalation.	___	___
5) Places earpieces of stethoscope in ears facing forward or pointing upward.	___	___
6) Uses diaphragm to auscultate with (flat side of stethoscope).	___	___
7) Uses systematic approach for auscultation:	___	___
a. progresses up or down the chest anteriorly and posteriorly comparing right side to left side or vice versa.		



DIAPHRAGM

UPON THE STUDENT'S COMPLETION OF THIS CHECKLIST RETURN IT TO HIM AND DISCUSS THE CRITERIA IN WHICH HE DID NOT PERFORM ADEQUATELY.

PROCEED ON TO THE NEXT PAGE.....

If you successfully completed both parts of the Post-Test--GREAT! We need more individuals with your ability. You are now ready to begin a new unit on Chest Exam or Assessment.

If you DID NOT successfully complete both parts of the Post-Test, perhaps you should run through it again to insure that you understand all of the techniques and procedures and information gained from using the stethoscope in auscultating the chest.

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A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

PRINCIPLES OF PHOTOMETRY

Unit 1

By

Bette J. Stanley, M.T. (ASCP), 1977

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TITLE OF PACKAGE:	Principles of Photometry UNIT 1
AUTHOR:	Bette J. Stanley, M.T. (ASCP)
INSTITUTION:	Lewis and Clark Community College, Godfrey, Ill.
INTENDED STUDENTS:	Beginning medical technology and MLT students.
ESTIMATED WORKING TIME:	30 minutes
MATERIALS NEEDED:	None

Note: Knowledge of scientific notation is a prerequisite for effective use of this unit.

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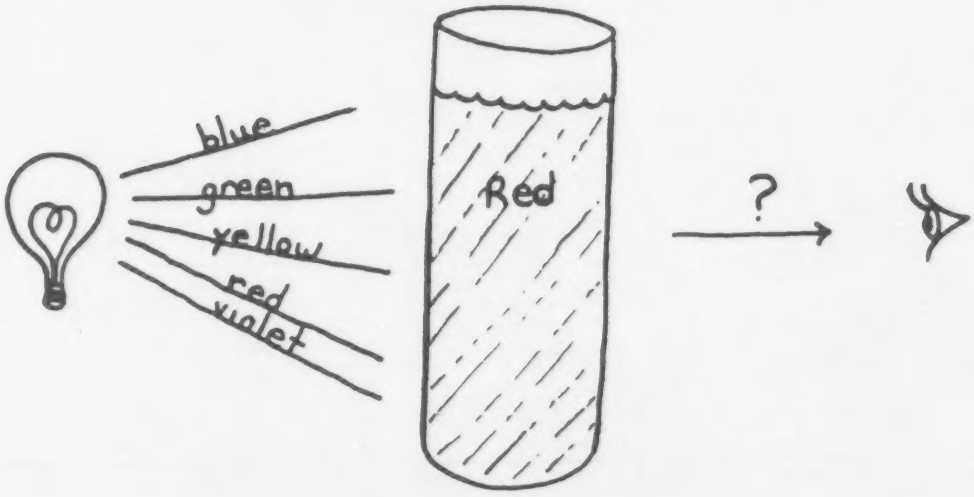
PRE-TEST

If you held up a red-colored solution in front of a light bulb, can you tell me what colors of light are being transmitted and absorbed.



Red is being transmitted/absorbed and all the other colors are
(circle one)

being transmitted/absorbed. Did you say red was being absorbed and
(circle one)

all the other colors of light were being transmitted? Well, you're wrong! If you answered that red was being transmitted and all the other colors are being absorbed, congratulations. You're right! But before you throw this unit in file 13 (wastebacket), look on page 3 and see if you can meet the objectives of this unit. If you cannot, please continue with the unit. If you can meet the objectives, how about trying my next unit on photometry.

Principles of Photometry

Unit I

Introduction

In the clinical laboratory one of the most basic instruments used is the photometer. If a component found in a body fluid can be made to form a colored solution, the concentration of that component can be quantitatively measured. In other words, if you can color it, you can tell how much is present in the body fluid in question, whether that fluid is blood, urine, cerebrospinal fluid, etc. However, before you can understand and correctly use a photometer, you must have a basic knowledge of light and its nature.

Direction

As you work your way through this program, answer each question. Don't worry about missing questions. I would like to see your post-test and read your comments on how to improve this self-instructional unit.

OBJECTIVES OF UNIT

Overall Objectives:

If you complete the program you should be able to describe some of the principles and nature of light and how these principles can be used in photometry.

Sub-Objectives:

You will have the opportunity to:

- -describe light as a form of energy.
- -state how electrons react when they are exposed to heat energy.
- -define wavelength.
- -discuss how colors are formed from sunlight.
- -relate wavelength to color and energy.
- -express wavelengths in metric units.
- -list the colors of the visible spectrum according to their relative wavelengths.
- -match the primary colors of light and their complimentary colors.
- -given the description of a colored solution, state what colors are being absorbed and transmitted.
- -choose the most appropriate color that will be best absorbed by a colored solution.

In addition to completing this self-instructional unit, you should be willing to further investigate the principles and laws of photometry in order to be able to effectively use and maintain a photometer in the clinical laboratory. I hope that you will also have some appreciation of the usefulness of photometry in the clinical laboratory. I hope you found this unit to be of some use and interest. Criticism of the unit will be greatly appreciated and used to improve the unit.

EXERCISE I

What is light? Is it that mysterious, intangible warmth from the sun that we take for granted, except on a cold, cloudy winter day. Light is a form of energy. Whenever a body or substance absorbs heat, energy is released by that body or substance in the form of light.

Light is a form of _____?

Check your answer at the top of Page 5.

Answer

1.) You're right if you answered that light is a form of energy.

Exercise 2:

If we look at light as a release of energy at the most elemental state, we find that if an atom is struck by heat energy (Fig. 1), light is given off (emitted). This occurs because the heat disturbs the outer orbiting electrons of the atom. These outer electrons are thrown out of their orbit to a "higher energy state". See Fig. 2. This change indicates that the electron absorbed the heat energy. When the heat energy is released and the electron returns to its orbit (ground state), light is emitted. (Fig. 3)

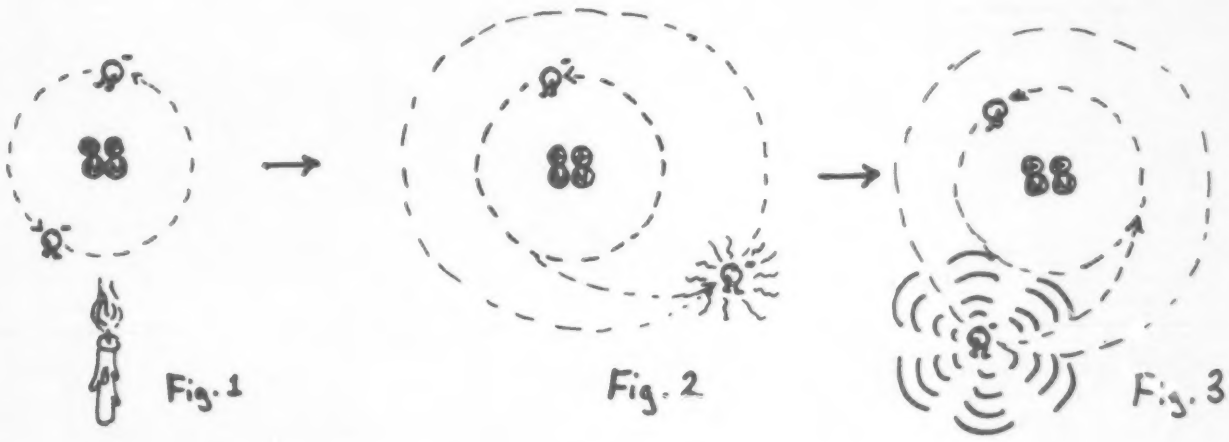


Fig. 1 Fig. 2 Fig. 3

When an atom absorbs heat, the electrons in the outer orbit move to a higher/lower energy state; and when the electrons return to their ground state _____ is emitted.

Answer

2.) You should have circled higher, because when the electrons absorb heat they become "energized". And when they become "unenergized", they fall back into their normal orbits. As the electrons return to their orbits light is emitted.

This concept is a little tricky. Makes you think back to your first chemistry course, doesn't it? Don't worry, this is not going to be a chemistry review. Please keep going.

Exercise 3:

The color or wavelength of light depends upon the energy change of the affected electrons. But what do we mean by wavelength? Light is generally considered to travel in wavelike motions.
See Fig. 4.

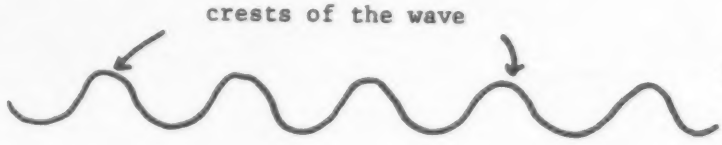


Fig. 4

Wavelength is the distance between two adjacent crests or one complete cycle of the wave. See Fig. 5

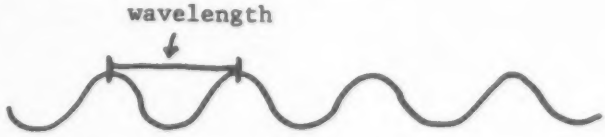


Fig. 5

The distance between two adjacent crests of a light wave is called the _____.

Check your answer at the top of next page.

Answer

3.) If you answered wavelength, you know what you're talking about.

Exercise 4:

One of the things that the energy of light depends upon is wavelength. Light with short waves has high energy. Light with long waves has low energy.

Short wave = high/low (circle one) energy

Long waves = high/low (circle one) energy

Check your answer at the top of next page.

Answer

4.) If you answered short waves = high energy and long waves = low energy, you are right.

How is it going so far?

Exercise 5:

The light from the sun appears to be pure white light. Actually, the sunlight contains many different wavelengths of light. If you direct sunlight through a glass prism, a rainbow or spectrum of colors would be produced. I'm sure you have seen this when looking at a diamond in sunlight and seen all the beautiful colors reflected. Each color has its own characteristic wavelength.

The color of light is determined by its _____.

Check your answer at the top of next page.

Answer

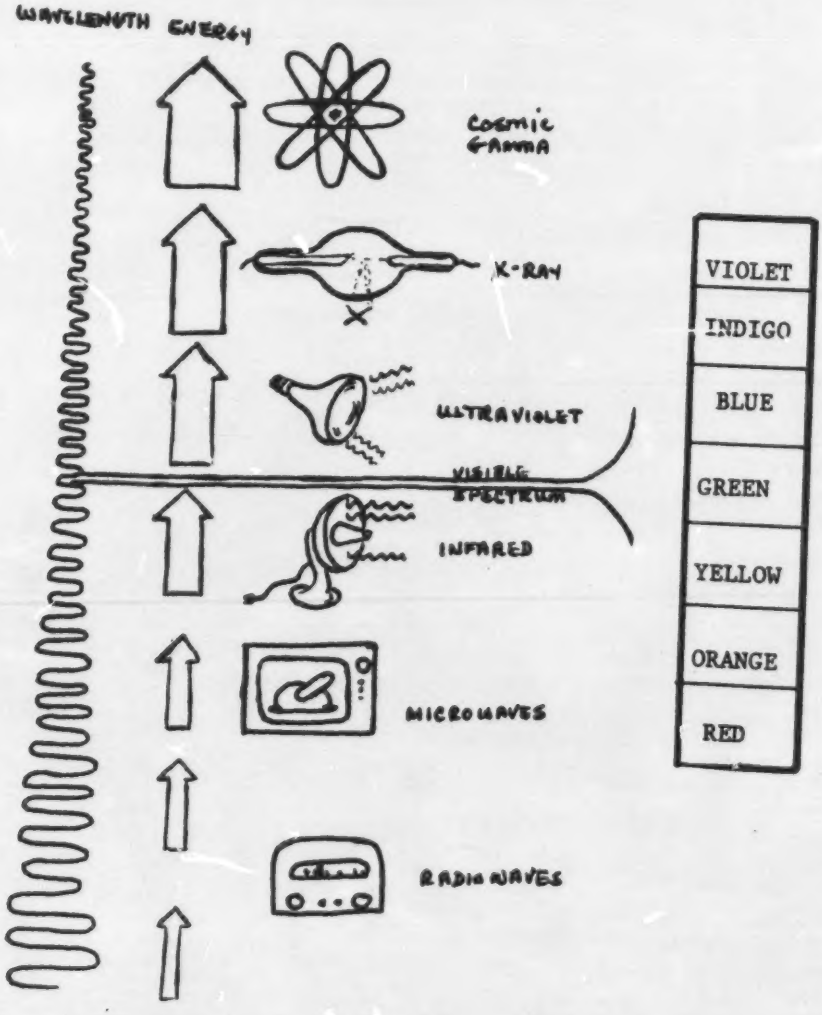
5.) Wavelength determines color.

Exercise 6:

The spectrum of colors is produced as sunlight and passes through the prism because the different wavelengths are bent (diffracted) to different degrees which makes each color come out separately.

See Fig. 6.

The colors that you can see with your eyes are only a small part of the electromagnetic spectrum. Look at Fig. 7 and compare the wavelength with the energy of the different types of radiation found in the electromagnetic spectrum.



Did you notice how the arrows representing energy become larger as the wavelengths become smaller?

As the wavelengths become smaller, the energy increases/decreases
(circle one)

Check your answer at the top of the next page.

Answer

6.) It's hard to believe but true, that waves which we can not see, such as x-rays, have more energy than ultraviolet rays which can burn you.

Exercise 7:

Since you have now realized the importance of wavelength, you should know the metric unit used to express wavelength (Greek symbol for wavelength is λ , lambda). In biology and medicine, wavelength is usually expressed in nanometers (nm).

1 nanometer = 1×10^{-9} meters = 1×10^{-6} millimeters = 10 angstroms (A)

I am assuming that you already know scientific notation. The common metric unit of measure for wavelength is the _____

Fill-in the following question marks.

1 meter = 1 x 10?nanometers or 1, $\frac{?}{\text{(fill in zeros)}}$ nanometer

Answer

7A.) I'm sure you answered nanometer.

7B.) 1 meter = 1 x 10^9 nanometers or 1 billion (9 zeroes) nanometers.

I hope you can think metric !!

Exercise 8

The colors of the visible spectrum if listed according to size of wavelength (shortest --- longest) are:

Color	Wavelength (nm)
Violet	400-440
Blue	440-490
Green	490-560
Yellow	560-600
Orange red	600-700
Infrared	longer than 700

Blue has a longer/shorter (circle one) wavelength than yellow. Orange red has a longer/shorter (circle one) wavelength than green.

Check your answer at top of next page.

Answer

8.) The wavelength of blue is shorter than yellow and orange red is longer than green.

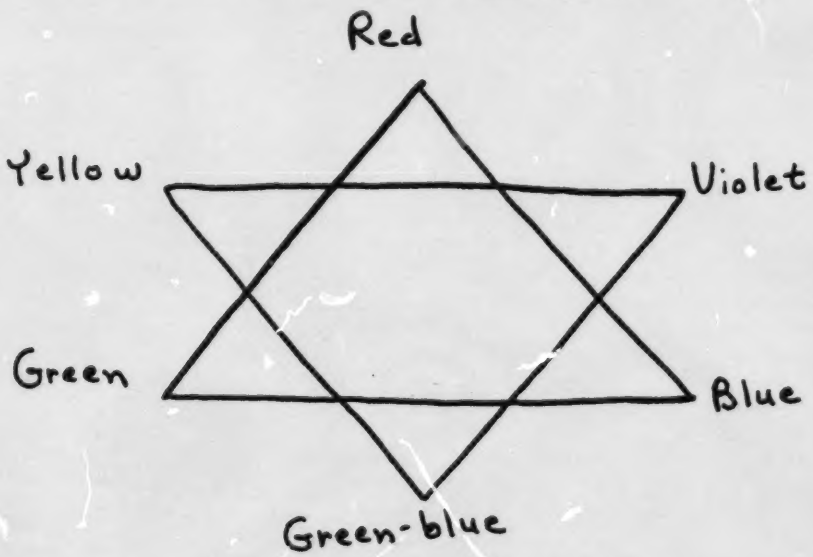
At this point, I think it is more important to know the order of the colors according to size of wavelength rather than the specific wavelength ranges. Range is something you can always look up.

Exercise 9:

The three primary colors of the visible spectrum are RED, BLUE, and GREEN. They each have a complimentary color.

Primary Color	Complimentary Color
Red	Green-blue
Blue	Yellow
Green	Violet

The relationship between the primary colors and their complimentary colors can be illustrated by a star. See Fig. 8.



You can color the star with the appropriate colors if you want. Seeing the colors and their relationship with each other may help you to remember them. (Notice: This is not like the color wheel that you made in third grade art class where red, blue, and yellow were the three primary colors.)

Draw a line matching the primary colors with their complimentary colors.

Primary Color	Complimentary Color
Blue	Violet
Green	Yellow
Red	Green-blue

Check your answers at the top of next page.

Answer

9.) If you matched blue and yellow, green and violet, and red and green-blue, you're on target.

Exercise 10:

If white light is allowed to pass through a colored solution, will all of the light come through? No. As you probably realize some of the light will be absorbed by the solution and the rest of the light will pass through (be transmitted). Let's use a solution of copper sulfate ($CuSO_4$) that appears blue to your eyes. The copper sulfate solution appears blue because all the other colors of the spectrum are absorbed by the solution. See Fig 9.

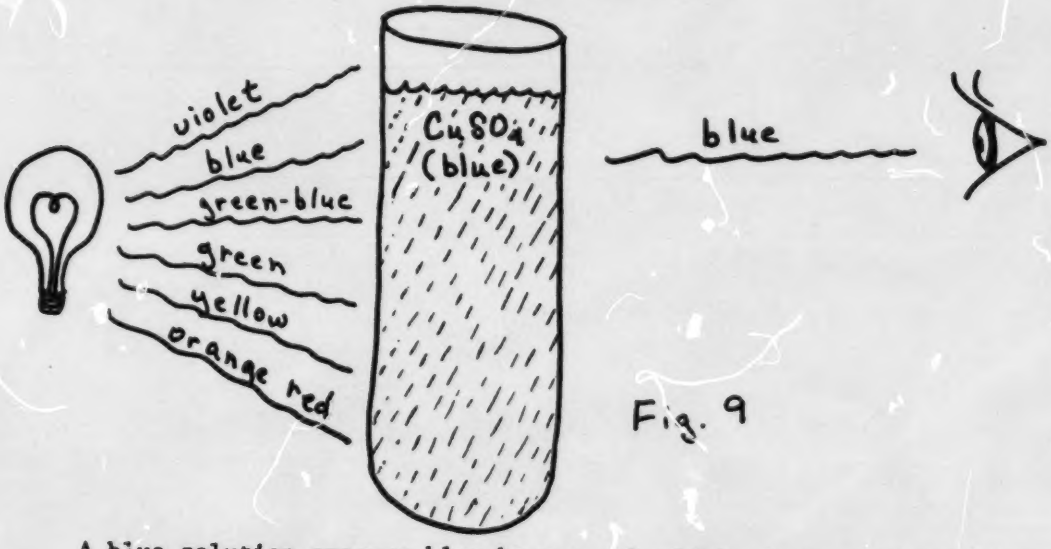


Fig. 9

A blue solution appears blue because the light is transmitted/absorbed (circle one) and the other colors of the spectrum are transmitted/absorbed. (circle one)

Check your answer at the top of next page.

Answer

10.) A blue solution transmits blue light, and absorbs the other colors.

You're doing great. Please keep going.

Exercise 11:

If you will refer back to the color star on page 16 (Fig. 8), a green solution will absorb the color violet best. Notice that violet is directly across from green on the star. Also, violet is the complimentary color of green. What color would a yellow solution absorb best?

Answer

11.) If you said blue, you're 100% correct. You got my message.

By now, you're probably asking yourself what all this has to do with the clinical laboratory. I mentioned in the introduction that if a component of the body fluids can be made into a colored solution, you could measure that component quantitatively (tell what its concentration is). The component's concentration can be measured in a photometer by using color and color variation. The concentration of a solution is directly proportional to the amount of light that the solution will absorb. The darker the color, the more light that will be absorbed. This is the basic law used in photometry and will be presented in further depth in another unit.

Now apply what you have learned and answer the questions on the post-test.

Post-Test

1. When a substance or body is subjected to heat, energy is released as _____.

2. When an atom absorbs heat, the electrons of the outer orbits move to a higher/lower energy.
(circle one)

3. When these electrons return to their normal orbit (ground state) _____ is emitted.

4. Light (radiant energy) travels in wavelike motions. On the following diagram, label the length of one wave.

5. Light with a short wavelength has a high/low energy.
(circle one)

6. The individual colors of light are determined by their _____.

7. X-rays have very long/short wavelengths and radiowaves are very long/short.
(circle one) (circle one)

8. Fill-in the correct colors for the following wavelength table.

Color	Wavelength (nm)
a._____	400-440
b._____	440-490
c._____	490-560
d._____	560-600
e._____	600-700
f._____	longer than 700

Post-Test (cont.)

9. List the three primary colors and the complimentary color of each.

	Primary Color	Complimentary Color
a.	_____	_____
b.	_____	_____
c.	_____	_____

10. If a solution appears violet, what color is being transmitted?

_____

11. What color will the violet solution absorb best? _____

12. Briefly describe how photometry can be used in the clinical laboratory.

13. This self-instruction unit was:

Clear	Confusing
Enjoyable	Boring
Useful	Useless

14. The content or ideas in this unit were:

Stimulating	Uninteresting
Important	Uninimportant
Well summarized	Too detailed
Explanatory	Confusing

Check answers of post-test with key on page 22.

Key for Post-Test

1. light
2. higher
3. light
4.

5. high
6. wavelength
7. short, long
8. violet
   blue
   green
   yellow
   orange red
   infrared
9. red — green-blue
   blue — yellow
   green — violet
10. violet
11. green
12. Can measure substances in body fluids with a photometer, if it can be colored.

Answer Sheet for Practice Questions

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

Answer Sheet for Post-Test

1.

2.

3.

4.

5.

6.

7.

8. a. d.

b. e.

c. f.

9. a. b. c.

10.

11.

12.

13.

14.